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DAMAGE ANALYSIS OF LOCAL OPERATING SYSTEMS,(U)

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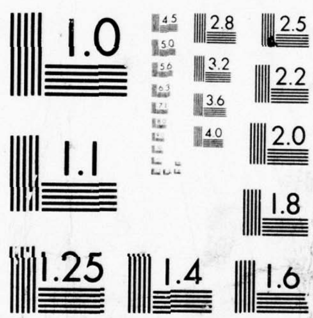

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RESEARCH TRIANGLE INSTITUTE

May 1979

DCPA Work Unit 4126J

Contract No. DCPA01-77-C-0238

Final Report RTI/1531/00-01F

DAMAGE ANALYSIS OF LOCAL OPERATING SYSTEMS

by

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Prepared for:

Defense Civil Preparedness Agency
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9 Final rept. Sep 77–May 79,

DETACHABLE SUMMARY

14 FINAL REPORT RTI/1531/00-01F

11 May [redacted]79

12 105p.

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for

DEFENSE CIVIL PREPAREDNESS AGENCY

DEPARTMENT OF DEFENSE

Washington, D.C. 20301

under

15 Contract No. DCPAØ1-77-C-Ø238

Work Unit 4126J

DCPA Review Notice

This report has been reviewed in the Defense Civil Preparedness Agency and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Defense Civil Preparedness Agency.

The research described herein covers a part of the "design" phase of a computer based dynamic system to Test and Evaluate Local Operating Systems, referred to as TELOS. This study was performed by Research Triangle Institute and was sponsored by the Defense Civil Preparedness Agency (DCPA) under Contract No. DCPA01-77-C-0238.

The long term goal of this DCPA effort is to develop a computer-based dynamic simulation capable of supporting the TELOS both generically, wherein component research, training and national assessment roles are pursued, and, specifically, wherein planning and training roles give direction to local systems. The purpose of the current RTI effort was to integrate all components of TELOS under an executive control; to convert TELOS to operate on the UNIVAC 1100/10 at DCPACC; and to demonstrate the ability of TELOS to simulate a local Civil Defense operating system.

A system overview is contained in this report with a brief description of all components. The simulation is summarized as follows: the system functions under a set of controls which govern an attack module that generates overpressure, thermal, and nuclear radiation levels at various points over the entire local area. The local area is described by a data base that can be varied by control inputs. The Area Damage Summary (ADS) module relates the resources to the environment levels and describes the resulting damage. The local countermeasures module (LEMOS) responds to problems derived from plans or an examination of resource damage after each attack event. Through various countermeasures, LEMOS either protects resources from subsequent damage or expends resources to relieve the distress resulting from the weapon effects. In either case, the location and state of local resources are altered. An iterative process between the countermeasures and damage assessment modules conducts operations through a number of time periods dictated by system control. An evaluation module analyzes the outputs from both ADS and LEMOS with respect to the particular role of TELOS. On the basis of this evaluation, controls for further data generation are determined and a new cycle begins.

The overall TELOS system is still incomplete although many of its missing elements are well defined. The primary activity during the current contract was concerned with testing and conversion of the LEMOS elements. All existing modules and submodels have been converted to operate on the UNIVAC 1100/10 computer at Olney, Maryland. That is, the same multi-area test runs have been successfully made on that machine. The files developed before conversion were used to confirm that the conversion to the UNIVAC 1100/10 was complete. Deficiencies of the system are identified and described as a basis for an overall plan for completing the TELOS system.

Based on the test and conversion activities performed, RTI recommends that extensions to TELOS, including a communication submodel and an evaluation module, be started immediately, that detailed documentation of all modules be initiated, and that further development effort be conducted using the UNIVAC 1100/10 remote terminal facilities at DCPACC. In addition, RTI recommends that the program plan outlined in this report become the basis for a fully validated DCPA program to reach the long term goal stated in paragraph 2 above.

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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER RTI-1531/00-01F	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) DAMAGE ANALYSIS OF LOCAL OPERATING SYSTEMS		5. TYPE OF REPORT & PERIOD COVERED Final Report 9/77-5/79 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) R. N. Hendry, R. O. Lyday, T. W. Della, K. J. Reeves		8. CONTRACT OR GRANT NUMBER(s) DCPA01-77-C-0238 new
9. PERFORMING ORGANIZATION NAME AND ADDRESS Research Triangle Institute P.O. Box 12194 Research Triangle Park, NC 27709		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Work Unit 4126J
11. CONTROLLING OFFICE NAME AND ADDRESS Defense Civil Preparedness Agency Washington, DC 20301		12. REPORT DATE May 1979 13. NUMBER OF PAGES 95
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Simulation, System Evaluation, Program Conversion, Model

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The research described herein covers a part of the "design" phase of a computer based dynamic system to Test and Evaluate Local Operating Systems, referred to as TELOS. The long term goal of this DCPA effort is to develop a computer-based dynamic simulation capable of supporting the TELOS both generically, wherein component research, training and national assessment roles are pursued, and, specifically, wherein planning and training roles give direction to local systems. The overall TELOS system is still incomplete Cont'

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RESEARCH TRIANGLE INSTITUTE
OPERATIONS ANALYSIS DIVISION
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27709

FINAL REPORT RTI/1531/00-01F

May 1979

Damage Analysis of Local Operating Systems

by

R. N. Hendry, R. O. Lyday, T. W. Della, and K. J. Reeves

for

DEFENSE CIVIL PREPAREDNESS AGENCY

Washington, D.C. 20301

under

Contract No. DCPA01-77-C-0238

Work Unit 4126J

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The research described herein covers a part of the "design" phase of a computer based dynamic system to Test and Evaluate Local Operating Systems, referred to as TELOS.

This work was sponsored by the Defense Civil Preparedness Agency (DCPA) under Contract No. DCPA01-77-C-0238 dated September 27, 1977, and as amended subsequently. Principal activities during the current period of performance were to complete the program tests and conversions described in Section III and Appendix B. The balance of this report is intended to update the status of the TELOS system development program.

The authors express their indebtedness to Mr. James Jacobs of DCPA for his guidance during the study. The authors also express their appreciation to Mr. Edward L. Hill and to others in the Research Triangle Institute who supported this research. A special note of appreciation is given to Mr. Thomas W. Della who during the course of this work made a significant contribution to the system integration effort and whose untimely death represented a very real loss to his associates and to this project.

A computer based simulation designed to Test and Evaluate Local Operating Systems (TELOS) has been under development for some time. During the past year, RTI has continued to refine the modules and overall main program of the Local Emergency Operating System (LEMOS) and to convert them to the UNIVAC 1100/10 operating system at DCPACC. The main accomplishment during the contract period has been the test runs using a small two-area data base to check the adequacy of the procedures to process the master file that is to be produced by the Area Damage Summary (ADS) System. At present, ADS does not produce the records in the master file which describe the damage states of Civil Defense resources. Therefore, the test data does not confirm the interface between the damage assessment submodel (ADS) and the countermeasures module of LEMOS. While the test data proved useful in verifying the essential interfaces between modules (file, record formats and data elements), it did not prove to be adequate to verify the accuracy of these data. Extensive testing will be required in a subsequent effort to demonstrate the overall reliability of the system outputs, especially those data produced from ADS. These reliability tests cannot be accomplished satisfactorily until ADS is modified to include the damage functions being developed by RTI under Contract No. DCPA01-78-C-0298. A development plan is included to suggest the implementation of the present model for each of the four primary roles to which TELOS may be applied.

LIST OF TABLES

A. Background

1. General

Considerable effort is required to develop and maintain a national civil defense posture consistent with current and proposed preparedness efforts. Dynamic modeling of target and host areas offers an effective technique to test and evaluate development alternatives and to support planning and surveillance programs. RTI has participated in the development of TELOS (a system of computers to Test and Evaluate Local Operating Systems) and LEMOS (a countermeasures model of the Local EMergency Operating System). LEMOS [Refs. 1-9], a component of TELOS, is intended to simulate dynamically the local civil defense operations. LEMOS is also capable of modeling a distributed and adaptive system that is critical to the survivability of the country [Ref. 10]. In particular, Reference 10 states, "In summary, the development of distributed survival systems, with strong adaptive properties, can both provide reliable and predictable survivability and recovery potential in the event of actual nuclear attack, and also provide a sound quantitative basis for a useful and efficient national emergency preparedness system."

TELOS/LEMOS has the potential to model multicounty target and host area operations as well as to test and evaluate the consequences of those operations. A multiyear research and planning effort could convert this prototype model into a basic program that could have a significant impact on the development of a national civil defense posture.

2. Postures

Program D [Ref. 11] envisions crisis evacuation as a "surge" of actions to upgrade host area protection for evacuees and in-place protection for non-evacuees. Program D', while having essentially the same goals as

Program D, reduces the level of funding and defers the achievement of goals until after 1983. The TELOS/LEMOS concepts support the dual evacuation/in-place concepts of both programs. The model envisions all counties as being assigned to multi-county groups, either target or host types. While the model evaluates a single group of counties, provision is made for resources to be imported and exported to or through neighboring groups. Thus, while specifically addressing local civil defense problems, the dynamic system is capable of modeling virtually any posture.

3. Issues

Development, deployment, and surveillance of an effective civil defense system involves the timely resolution of a number of critical issues [Ref. 12]. TELOS/LEMOS has the potential for estimating:

* Dynamic City Evacuation
- Economic Modeling and Impact
- Industrial Protection and Recovery
- State/Local Organizational Structure
* Communications, Direction, and Control
* Training Requirements and Techniques
- Public Information
* Transportation
* Crisis Relocation Planning and Other Preparedness Design Issues
- Physical Protection Techniques
- Slanting Techniques
- Blast/Fire and Other Effects
- Radef and Remote Sensing

- Health and Medical Issues and Problems
- * Dynamic Model of Victim Needs
- CBR Defense Capabilities

4. Roles of Dynamic Modeling

The issues identified above with an asterisk may be addressed at least in part by a dynamic simulation of local (multicounty) operations which is under the direction of a scenario controller and evaluated by an output analyzer. The following four roles have been identified [Ref. 6] wherein a dynamic simulation can offer constructive support to activities of DCPA:

- Coordinate component research contributions to local operating systems
- Prepare damage functions for national assessment of civil preparedness
- Evaluate alternative local operating plans and procedures
- Support local civil defense training through operation simulations

The four roles identified above and described below are not intended as an exhaustive treatment of the roles for dynamic simulation in testing and evaluating local operating systems. They were included to suggest the potential value of the basic computer based system.

Previous research efforts by the Research Triangle Institute (RTI) for the Office of Civil Defense [Refs. 1-9] have been directed toward describing the total local civil defense system, synthesizing a total analytical framework, and synthesizing the basic subsystem elements of a local countermeasures model.

a. Component Research Support

The dynamic simulation may be used as a "test bed" for the products of component research provided the component study has been designed to yield products which will interface with it. For example, if component studies yielded specific time relationships between thermal ignition and room flash over, the fire spread submodel planned for ADS could assess the impact of new time relationships on firefighting operations. Similarly, if component studies yielded injury treatment times and probabilities of recovery different from previous studies, the resulting effects on medical operations could be evaluated.

b. National Assessment of Local Readiness Levels

If a sufficient sample of local operations could be dynamically simulated under various scenarios, the cumulative results of these simulations may be used to generate damage functions amenable to national assessment in the manner suggested by the Analytical Nuclear Casualty Estimation Technique (ANCET) developed for DCPA by RTI [Ref. 13]. As component research, better training, or better planning alter the national posture, annual assessments could be made to identify the relative impact of each improvement on assessment outcomes. Moreover, these damage functions may be related to different attack scenarios and levels of readiness attributed to local operating systems.

c. Local Planning Support

Planning activities result in a number of plans which will govern the state-of-readiness of localities either as target or host areas. Manuals [Refs. 14-15] have been prepared to guide local planning alternatives. Written plans are amenable to evaluation by a dynamic

simulation. Results of simulation activities may be used to aid in choosing between alternative plans or providing guidance in creating new plans. Outputs could suggest preferred routes to be used in relocating the population, locations for constructing expedient shelter, better operating policies and priorities, and better deployment of available civil defense resources.

d. Civil Defense Training

A dynamic simulation may be used in at least two ways to support the training of key civil defense personnel. First, scenarios may be constructed in which key local civil defense personnel are permitted to react interactively to change certain inputs to the simulation or interrupt and alter simulation controls at any time and, thereby, learn what options are available to him and how to manage them to achieve better outcomes. Second, simulation runs may be designed to support a group acting together in a simulated Emergency Operating Center (EOC) in situations approximating "real time". While these two roles are believed to be attainable, the present model has not been designed specifically to support them. Such adapatations are not recommended until the basic system has been proven in the other three roles.

5. Level of Detail

Simulation of local operations is practicable by the use of computer-based models, provided the user avoids too much detail which renders the simulation time-consuming and, therefore, expensive. The authors believe that, while the current TELOS design is seemingly complex, it has, in fact, avoided this pitfall and achieved a suitable balance between too little and too much detail. The transportation submodel

described in Section III typifies this belief. The network could have been more or less detailed. The level of detail adopted is thought to give enough realism or believability and, yet, not require endless data processing.

With this background, the objectives of RTI's current efforts to construct a basic dynamic simulation that models local civil defense operations under nuclear attack can now be stated in the proper context.

B. Objective

1. General

The long term goal is to develop a computer based dynamic simulation capable of supporting the Test and Evaluation of Local Operating Systems both generically, wherein component research, training and national assessment roles are pursued and, specifically, wherein planning and training roles give direction to local systems.

2. Short Term

The purpose of the current effort is to integrate GENUA, LOCATE, ADS, and LEMOS under an executive control; to convert TELOS to operate on the UNIVAC 1100/10 at DCPACC; and to demonstrate the ability of TELOS to simulate a local Civil Defense operating system's response to nuclear weapons effects and to determine the effectiveness of this response.

3. Current Contract

The Statement of Work in Contract No. DCPA01-77-C-0238 is as follows:

> *Based upon prior research and development which produced (a) the TELOS Attack Environment model, (b) the TELOS Area Damage Summary model, and (c) the TELOS Local Emergency Operating System model, develop the currently designed elements into an integrated operational system on the DCPA UNIVAC 1100/10 computer.*

Test, exercise, and modify the resulting TELOS computer model as necessary to bring it to demonstrable effectiveness. The testing is to be performed utilizing a case study approach. The case study design will be developed in consultation with DCPA.

C. Technical Approach

The overall system design approach evolved from the Five-City Study. A three step process was employed. In step one, local operating systems were studied and data collected. In step two, these data were analyzed to identify, classify and describe all elements of the system. These analyses produced descriptions of time phases, operating areas, problem definitions, and functions and controls to solve problems. In step three, a system was synthesized to permit the test and evaluation of alternative countermeasure systems. This early effort, now viewed as Phase I, produced the overall TELOS system described in Figure 1 [Ref. 9]. At that time, RTI was involved in only two of the subsystems; namely, Attack and Countermeasures.

From this simple overall design concept, the technical approach to the computer based system development envisioned four subsequent phases: subsystem design and coding; system integration tests; demonstration tests; and case study effort including case planning, simulation execution and data evaluation. This early approach anticipated only the fulfillment of the role of system evaluation for component research during the transattack period. If other roles were to be fulfilled, additional phases would be needed.

The current overall design concept envisions interactive procedures for the control and evaluation subsystems and batch procedures for the remaining subsystems.

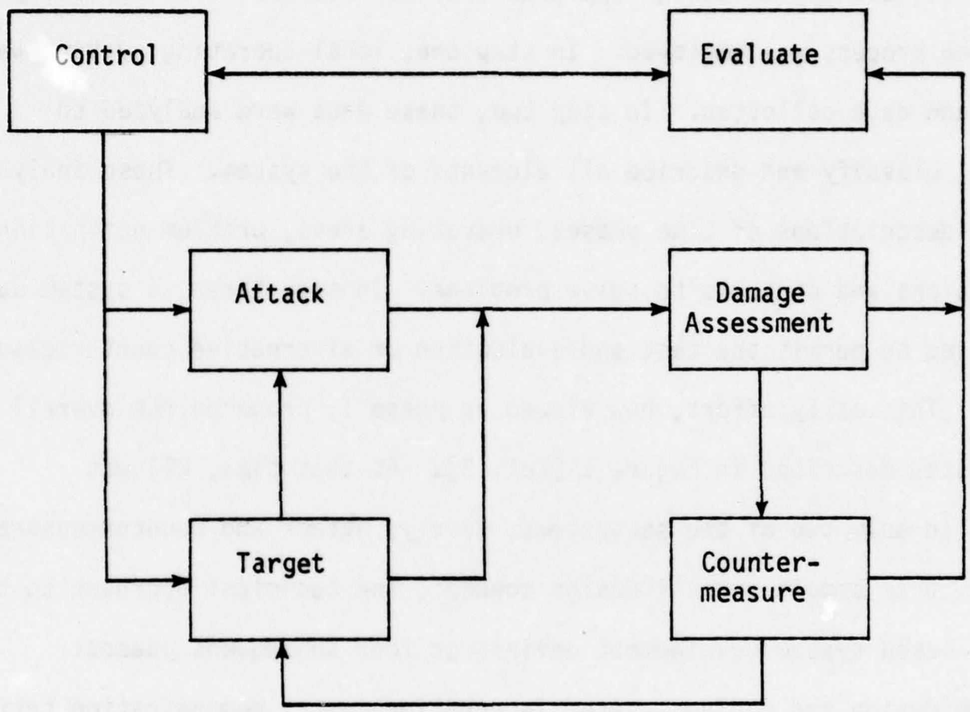


Figure 1. Overall TELOS System

D. Organization of Report

The manner in which this concept has been implemented is described in Section II. The system development status is described in Section III in the context of the development plan in the next section. A proposed overall program plan envisioning the fulfillment of all roles is presented in Section IV. The overall situation is discussed in Section V, followed by conclusions and recommendations in the last section.

A. Overview of System

Initially, the system user plans the scenario and controls inputs required to meet his evaluation requirements. Since neither the control module nor the evaluation modules have been developed as yet, these modules in the system are not well defined. However, RTI's current concepts regarding them are contained in subsections C and G, respectively. The remaining modules are well defined.

TELOS functions under a set of controls which govern an attack module that generates overpressure, thermal, and nuclear radiation levels at various points over the entire local area. The local area is described by a data base that can be varied by control inputs. The Area Damage Summary (ADS) module relates the resources to the environment levels and describes the resulting damage. The local countermeasures module (LEMOS) responds to problems derived from evaluation and "surge" period plans or an examination of resource damage after each attack event. Through various countermeasures, LEMOS either protects resources from subsequent damage or expends resources to relieve the distress resulting from the weapon effects. In either case, the location and state of local resources are altered.

An iterative or dynamic process between the countermeasures and damage assessment modules conducts operations through a number of time periods dictated by system control. An evaluation module analyzes the outputs from both ADS and LEMOS with respect to the particular role of TELOS. On the basis of this evaluation, controls for further data generation are determined and a new cycle begins. If evaluation goals with respect to the

roles being performed by TELOS are achieved, appropriate reports are generated that reflect the outcome with respect to these goals.

Figure 2 is a hierarchial diagram or Volume Table of Contents (VTOC) identifying all of the elements of the "dynamic" TELOS system. Another version of the system called the "static" version does not contain the scenario, countermeasures or evaluation modules.

B. Resident Main Program (DCPA MAIN)

The overall control of the TELOS sytem of programs is maintained by a core program which remains in residence throughout the user session. The system operates in overlay as described in an earlier report [Ref. 9] and calls into the system the modules required to implement specific functions involved in the evaluation of local operations. The system is controlled by initial inputs or inputs at designated break points defined at the time of initial inputs. Initial and breakpoint inputs are secured through the scenario module.

C. Scenario Module (CONTROL)

Inputs are planned to be controlled by this module by interactive methods. The purpose of these inputs is to define the exogenous events, weather, higher executive decisions [Ref. 15], and other factors influencing the evaluation; local plans, policies, priorities, limitations and procedures; prevailing local situations; reference tables concerning team performance and organization; and output data requirements for the evaluation module together with controls over the final evaluation results. A list of controls is shown in Table I. This list, in part, is used by LEMOS and, when expanded, may serve for TELOS. Defaults for all inputs will

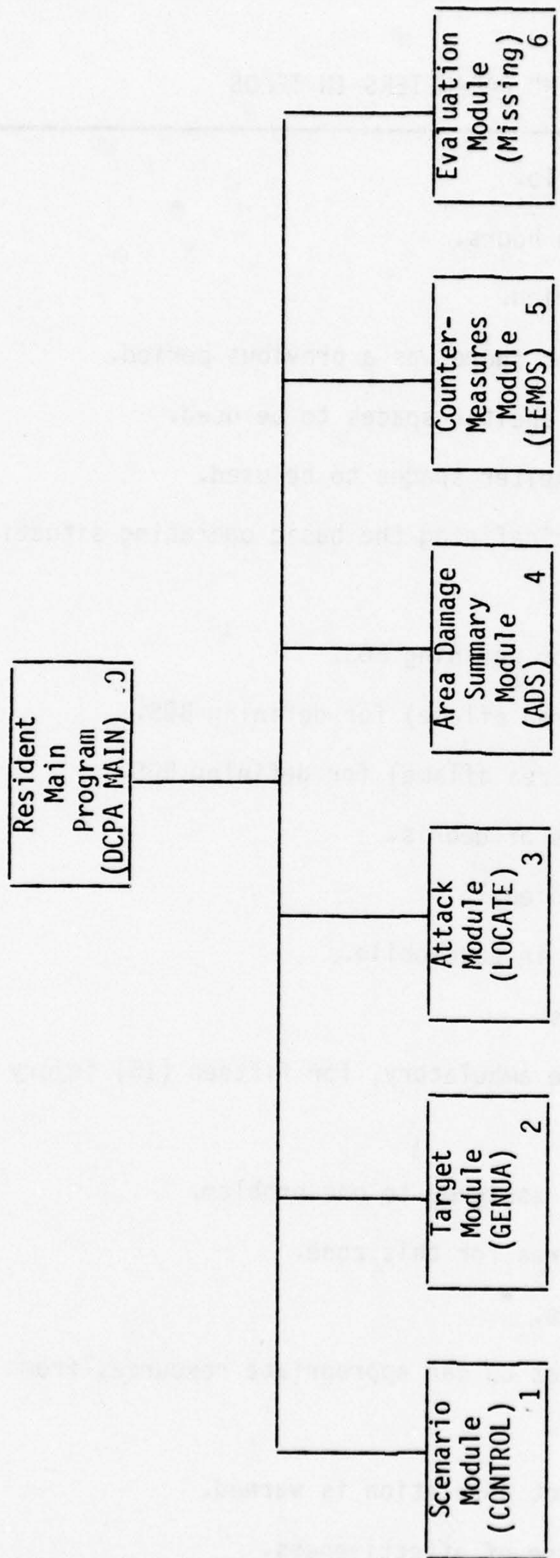


Figure 2. Components of TELOS

TABLE I: "COMMON" PARAMETERS IN TELOS

1. Hours from beginning of scenario.
2. Duration of current period, in hours.
3. Sequence number of current period.
4. Flag to indicate whether or not there was a previous period.
5. Code for minimum PF level for shelter spaces to be used.
6. Code for maximum height for shelter spaces to be used.
7. Low radiation level (RADS) for defining the basic operating situation (BOS).
8. High radiation level (RADS) for defining BOS.
9. Low fire level (fraction of area aflame) for defining BOS.
10. High fire level (fraction of area aflame) for defining BOS.
11. Codes for defining five depths of debris.
12. Zone number of area being studied.
13. Level of PF provided by being in automobile.
14. Length of work shift, in hours.
15. Fraction of casualties who are ambulatory, for fifteen (15) injury categories.
16. Maximum number of teams to be assigned to one problem.
17. Identification of sanctuary area for this zone.
18. Priority ranking of operations.
19. Code to indicate whether or not CD can appropriate resources from residences.
20. Code to indicate whether or not population is warned.
21. Weights used to compute measure of effectiveness.

minimize the amount of interactive time required to initiate the more frequently used controls. A program prototype (PGMO) for this module was initiated some time ago to permit the generation or alteration of the master file and/or reference file. With some modifications this program may serve as a scenario module. It may also be combined with the program called GENUA, that was developed by DCPACC to describe the target and/or operating areas.

D. Target Module (GENUA)

The unit areas within the target (GENUA) module are composed of from one to eight census tracts as defined in the 1970 census. The criteria involved in determining a unit area include uniformity of size, conformity to political subdivisions, and availability of information about these areas.

The calculations involved in finding the latitude and longitude of each unit area have been developed. The area of each census tract in a particular unit area is divided by the total area of the unit giving a fraction for each census tract. Next, the latitude and longitude for each census tract are multiplied by its respective fraction. These products are added for all census tracts within a unit area giving the latitude and longitude of the centroid of the unit area.

GENUA is an interactive program that allows the operator to develop a target area based on typical unit areas having the following building characteristics:

RS = Single-Family Residential
RM = Mixed Residential
RC = Residential-Commerical
CR = Commercial- Residential
CS = Commercial-Single
CM = Commercial-Mixed
IN = Industrial-Commercial

Data concerning these typical classes are called up from a reference file to aid in building the operating area model. A given unit area may have more than one of these land use classes. Each unit area has a centroid defined by latitude and longitude. This module has not been modified to generate a master file containing the civil defense resources needed by the countermeasures module.

At present GENUA does not have any subroutines. It generates a master file for use by ADS along with an attack environment file from LOCATE as described in the next subsection.

E. Attack Module (LOCATE)

A set of weapons defined in the scenario is used by LOCATE to determine the attack environments in each of the unit areas defined in the target module. The master file from GENUA is processed to determine the location of each area. LOCATE was developed from a model called ANCET [Ref. 13] and still includes some of its subroutines. Figure 3 shows the elements of LOCATE. The UNSCLZ subroutine uses the WSEG-10-NAS model to calculate the unshielded radiological dose for the population center. The other subroutines determine either the geometric relationships between weapons and unit areas or they calculate initial radiation, thermal energy or fallout values for these areas. The output is a file of weapon effects by period and by unit area. Parameters which are recognized in LOCATE for each weapon are:

- Latitude
- Longitude
- Yield

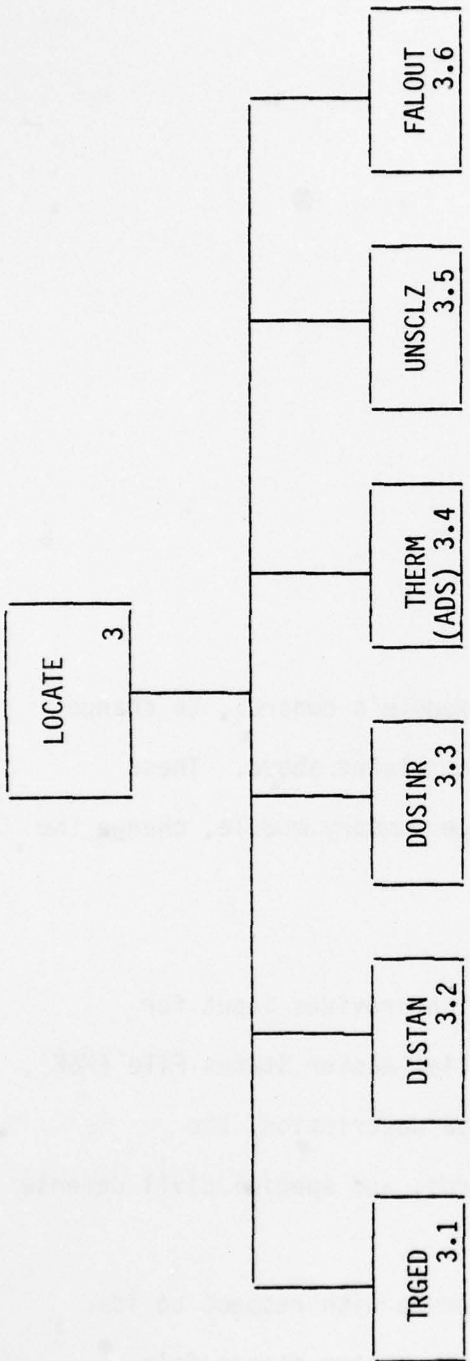


Figure 3. Components of LOCATE

- Fission/Fusion Ratio
- Height of Burst
- Wind Velocity
- Wind Direction
- Time of Detonation
- Visibility
- Air Density
- Cross Wind Shear
- Attack Start Time
- Initial Time Interval
- Second Interval Start Time
- Second Time Interval

The program operator is able, under this module's control, to change interactively some of the attack characteristics listed above. These changes will, upon assessment in the area damage summary module, change the effects on the resources in the target area.

F. Area Damage Summary Module (ADS)

ADS interfaces with the attack module, which provides input for necessary environmental effects data. The initial Master Status File (MSF), organized by unit area, contains the target area description, the structures, shelter, and personnel status records, and special civil defense resources records.

Figure 4 shows the organization of this module with respect to its subroutines. GETMST gets unit area data from the master status file. ADVTME advances time for fire spread and injury deaths. GETEFF gets

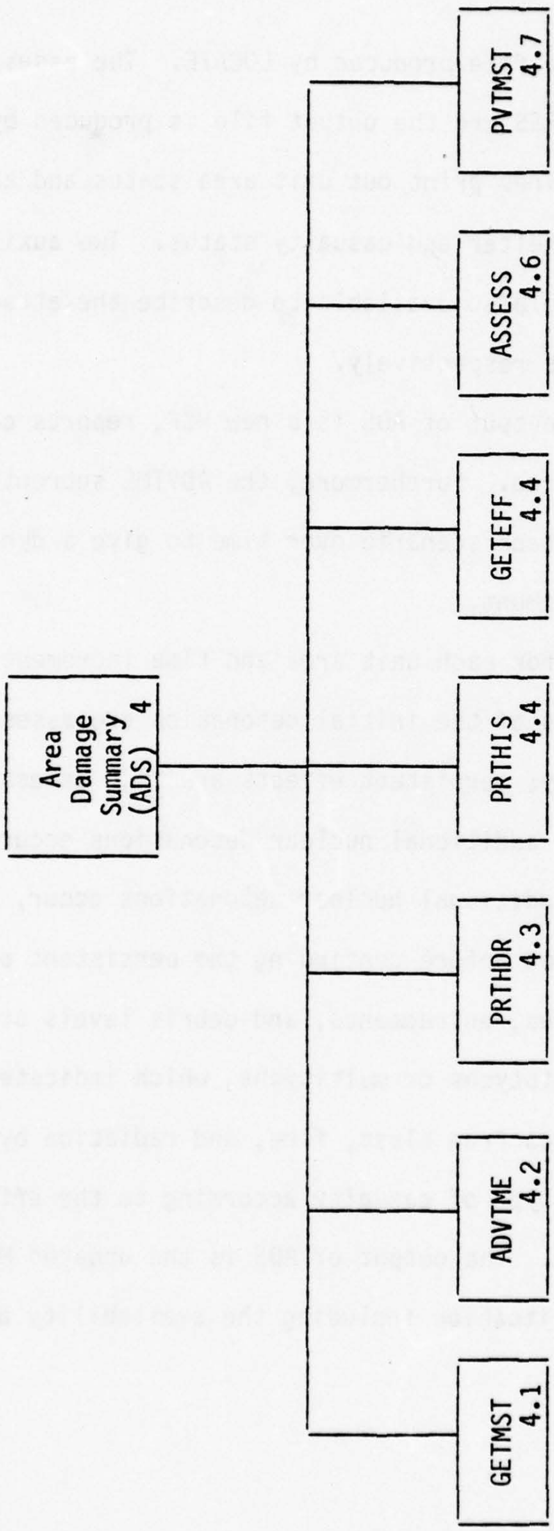


Figure 4. Components of ADS

environmental effects from the file produced by LOCATE. The assessment of damage is accomplished in ASSESS and the output file is produced by PVTMST. The PRTHDR and PRTHIS subroutines print out unit area status and an output report describing facility, shelter and casualty status. Two auxiliary programs PRTEFF and PRTYCH are also available to describe the attack conditions and multitych files respectively.

Thus, while the primary output of ADS is a new MSF, reports can be printed or suppressed as desired. Furthermore, the ADVTME subroutine is available to increment the attack scenario over time to give a dynamic character to the damage assessment.

The ADS updates the MSF for each unit area and time increment. In all unit areas, the prompt effects of the initial detonation are assessed for both target area and inventory; persistent effects are then assessed by single time increments unless additional nuclear detonations occur or the evaluation period ends. If additional nuclear detonations occur, prompt effects assessment is performed before continuing the persistent effects assessment. Damage, casualties, entrapments, and debris levels are determined on the basis of triptychs or multitychs, which indicate the degree of damage and casualties from blast, fire, and radiation by structure type, personnel posture, and type of casualty according to the effects data provided by the attack module. The output of ADS is the updated MSF. These records reflect the current situation including the availability and the condition of resources.

G. Countermeasures Module (LEMOS)

Figure 5 shows the major elements that make up the LEMOS module. The following paragraphs describe briefly each of the major elements which define the countermeasure activities.

Organization of civil defense countermeasures to meet undesirable situations begins with the problem definition (PROB) submodel. Each resource in the MSF is examined with respect to its damage stage and environment. A set of problems is identified which requires that a countermeasure be conducted to solve or improve the situation. Availability of CD resources is defined by a resource matrix organized by land use or service function and resource type associated with each function. The output of the problem definition submodel is a Resource File and a Problem File containing four general classes of problems: control, readiness, damage control, and relief and rehabilitation. The objective of LEMOS is to resolve all of these problems. The first function of the requirements (REQS) submodel is to update service records and identify increased readiness and control problems. Then, each problem is addressed by selecting alternative operations, each of which is designed to solve the set of problems confronting the people and/or teams residing in that unit area. Team assignments are determined that will implement any of these alternatives. The output of the requirements submodel is an Operations File that records the alternative solutions to all problems defined by the Problem File and an Assignment File that records each function in each operation. In addition, a service file is produced that defines team status.

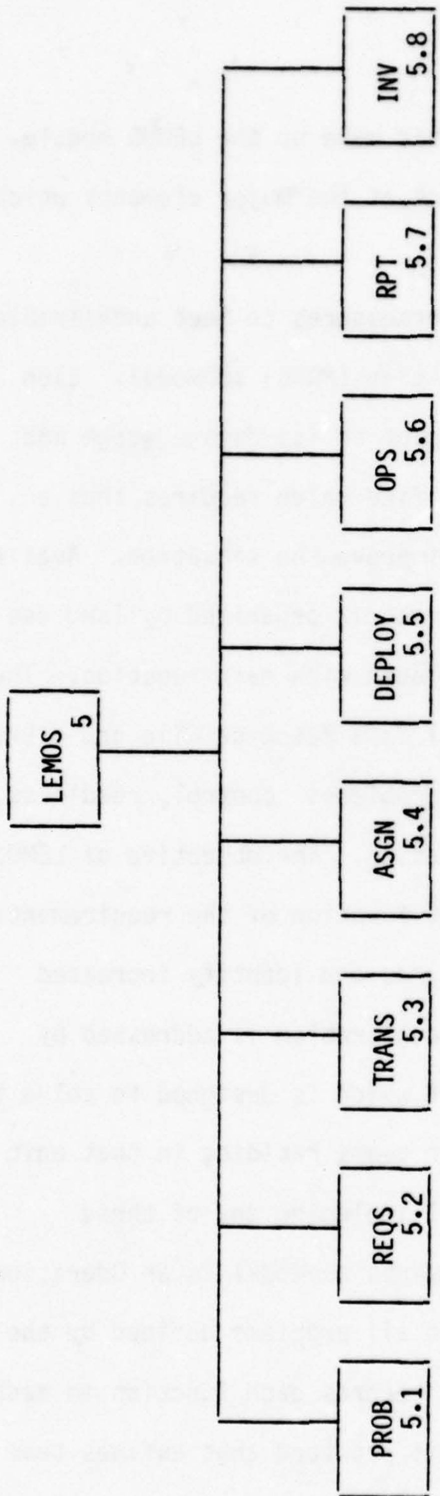


Figure 5. Components of LEMOS

The transportation (TRANS) submodel contains a series of programs that determine the minimum transportation times between unit areas. Freeways and major arteries are the basis of the current development of the transportation network. Residential and feeder streets are not included as they unnecessarily expand the network to unmanageable proportions.

The output from this submodel is a Travel Reference (TVLREF) File that quantifies the travel time between unit areas after considering the damage and operating environments affecting the transportation system in the zone of operations.

The assignment (ASGN) submodel uses the operations and initial Assignment File from the requirements submodel and the Travel Reference File from the transportation submodel. The number of teams and the average time each team requires to implement each operation are used, subject to constraint, to determine assignments for all teams under the jurisdiction of a specified control point. This allocation procedure [Ref. 3], an adaptation of an efficient algorithm developed by RTI [Refs. 16-17], assigns resources to alternative programs.

Planning for team and supply distribution over the network of lines and links is accomplished in the deployment (DEPLOY) submodel. A minimum Route (TVLREF) File was generated in the transportation submodel for all moves between admissible origins and destinations within a network. This file was used to generate the Trip File as the primary output of the deployment submodel.

Normally, deployment is made possible at the beginning of the operations phase at rates specified by two trip records generated in the

deployment submodel. These two records are sorted into origin and destination locations in a sorting operation between the deployment and operations submodels. Operations records are processed in the operations (OPS) submodel by priority in the presence of assignment records organized by area, operation number, and land use. Available resources are expended in exchange for problem resolution. Changes in resource states are recorded in the Benefit, Problem, and Resource Files.

The Benefit File is used in the report generating (RPT) submodel to describe benefits, readiness, and team effectiveness. The changed Resource and Problem Files are input to the final step in the countermeasures module before redefining the resource status and recording the vulnerablity in the Inventory Status File. The first is a Performance File generated in the operations submodel. It contains team performance, population benefits, and readiness information. The second file contains historical operations data from previous periods. The program has the capability of plotting data from the two files to allow visual scanning for significant changes over time.

The final module in the LEMOS series of programs is called the inventory protection (INV) submodel. People are loaded into shelters, and inventory records are prepared according to the control policy and posture constraints prevailing at each location. This model uses the Problem and Resource Files from the operations submodel to update the status of resources in the MSF from the damage assessment (ADS) submodel.

At this point in the evaluation, one pass has been completed through the countermeasures module by taking the Master Status File from the damage assessment (ADS) submodel and returning a modified file to reflect civil

defense countermeasures during the specified time interval. In the course of planning and executing the specified countermeasures, a number of files were created, modified, and retained for the next process period. Processing continues until the number of time periods required by the system control submodel terminates the simulation. A large number of printout options provided within the LEMOS and ADS yields a running description of system performance. Output data may be processed by the evaluation module at the conclusion of each pass or at the time of scenario termination.

H. Evaluation Module (EVAL)

While this module has not been developed, its basic functions include the analysis of the outputs generated from ADS and LEMOS. The purpose of system evaluation is primarily that of providing information concerning the effects of changes to the system (inputs or models) on the output variables. For the total CD system or a subsystem within it, measures of benefits are derived from a comparison of performance among alternative strategies or sets of resources performing under similar circumstances. In this context, system evaluation will facilitate the resolution of questions such as:

(1) What are the most effective CD plans and policies for a given local operating system? How sensitive are the optimal plans to changes in the inputs?

(2) How do uncertainties in the inputs and TELOS models affect the predicted outcome consequences? What are the input parameters for a given strategy that have the greatest influence on the effectiveness of the countermeasures?

(3) What is the most effective plan, assuming the "worst" attack scenario for this region? How should local operating decisions take into account the potential for multiple weapon detonations during the transattack period?

(4) What are the survival probabilities considering uncertainties in the input parameters defining the attack scenario and the effectiveness of CD countermeasures?

(5) What are appropriate measures of CD effectiveness? How should the multiattribute nature of the figure of merit be treated in the system evaluation? How does the optimality of the various possible countermeasure strategies vary according to the different possible methods of combining individual attributes (e.g., injury-free surviving population, subsistence capacity, surviving industrial capacity, etc.)?

There are three distinct elements that must be developed in the evaluation methodology for the consideration of questions such as these in the assessment of alternative CD strategies. The first involves the determination of appropriate measures of CD effectiveness, as suggested in question 5 above. This part of the evaluation is termed <u>value or utility analysis</u> and is concerned with the specification of valuation preferences of CD objectives as they pertain to the outcome consequences predicted by TELOS. By developing proper measures that reflect CD objectives and recognizing the multiattribute aspect of these goals [Ref. 18], alternative plans and strategies can be systematically evaluated to ensure the maximization of these objectives. The second element of the evaluation

module is sensitivity analysis, i.e., the identification of the significant variables and the importance of uncertainties in these variables. Through sensitivity analysis, answers can be obtained to a variety of important questions, such as 1, 2, and 4 above. Using methods that rely on experimental design techniques, group screening, response surface methodology, and Monte Carlo techniques, the important statistical as well as operational characteristics of a particular CD plan can be assessed. The final component of the system evaluation involves the application of decision analysis methods to alternative CD strategies. Using the results of the value analysis and sensitivity analysis, alternative plans can be systematically evaluated and the optimal decision sequence identified. Strategies that maximize the expected value benefits of CD operation under conditions of risk can also be compared to those that minimize CD losses under the worst case scenarios. Contingency plans can be developed that reflect the valuation preferences of national as well as local CD planners. In the following, a brief discussion is made of each of these three major elements that are necessary for the system evaluation module of TELOS.

1. Measure of CD Effectiveness

The information generated and processed in TELOS can be considered to define an entire range of attributes, each of which may be a measure of the benefits or effectiveness of CD operations. System performance objectives may include population survival, postattack survival capabilities, industrial protection and recovery capabilities, etc. The attributes, or criteria, that determine the degree to which such objectives are realized could include communications, transportation, shelter

protection, housing, fire, medical considerations, etc. In evaluating multiple objectives, the problem of value tradeoffs is implied in the choice of one plan over another if no one CD strategy dominates other alternatives. The value analysis involves the generation of a proper objective heirarchy, selecting attributes for these objectives, and developing tradeoff preferences and functions for use in the decision analysis. Sequential elimination techniques [Ref. 19], using the methods of dominance and constraints can, in some cases, eliminate alternative strategies, but weighting techniques and multiattribute utility theory will be required for a general assessment of CD effectiveness.

Several measures of CD effectiveness have been previously suggested [Ref. 6] and include the following:

- Relative-Well-Being (RWB)
- Readiness (RDY)
- Team Effectiveness (E)
- Cost (C)

These measures were suggested to provide information that described, respectively, the relative state of the population at a point in the emergency period, the potential for gain due to civil defense activity and the value of preattack preparations, the effectiveness of team operations, and the expenditure of team-hour resources. Weighting schemes were employed to combine the pertinent attributes. For example, the RWB measure employed such attributes as surviving population (S_t), labor potential of survivors (L_t), production capacity (V_t), and housing capacity (H_c). The attributes for team effectiveness included availability (A), reliability (R), and utility (U).

In the formal development of the system evaluation module, other measures of effectiveness, in conjunction with the possible use of multiattribute utility theory to assess tradeoff preferences in the CD objective hierarchy, will need to be considered. This will ensure that the measures of effectiveness are rationally developed and also consistent with CD goals.

2. Sensitivity Analysis

With properly developed measures of CD effectiveness, a systematic analysis of the sensitivity of TELOS is the second integral part of the evaluation module. For the system of computer models that form TELOS, the assessment of system sensitivity can incorporate several of the statistical techniques that have been applied to other complex systems (and computer codes), such as applications in nuclear reactor safety analysis [e.g., Refs. 20-21]. The following steps suggest a possible methodology that could be employed for the sensitivity analysis of TELOS:

1. Use technical knowledge and group screening methods to reduce the number of important variables to 10 or so for a given attack scenario and target description.
2. Run a one-at-a-time design using the reduced set of input variable in a 3 level input pattern (i.e., $\mu-4\sigma$, μ, $\mu + 4\sigma$). Plot the results for indication of relative importance and further elimination.
3. Augment the one-at-a-time design to create more levels for any variables that may require transformation to make their behavior more linear.

4. Construct an appropriate fractional factorial design in the remaining variables so as to comprise a reasonable response surface design and fit the surface.

5. Use Monte Carlo methods on the fitted response surface to compute the probabilities of the various predicted outcome consequences.

This type of approach would provide for a systematic identification of the most critical parameters in the evaluation of a particular CD strategy. The methodology would also facilitate the modification and refinement of any TELOS models by identifying the most important parameters. It would be possible to rank the variables in terms of their contribution to the particular measure of CD effectiveness considered. Finally, the developed response surface function will permit the estimation of the likelihood or probabilities that the measures of CD effectiveness are achieved for a given local CD plan.

3. Decision Analysis

The final component of the evaluation module is the analysis of alternative CD plans and policies. Decision analysis methodology [e.g., Refs. 22-23] provides a rational means to determine optimal strategies in the presence of uncertainty. In the context of CD operations, uncertainty can be considered to exist in the specification of the attack scenario, the effects of weapons, the effectiveness of CD countermeasures, etc. This uncertainty can be treated in several ways according to the traditional classes of decision analyses problems. Decision analysis under conditions of risk, uncertainty, or conflict can be applied according to the amount of information available about the various states that may occur. A major

advantage of using decision analysis formalism is that alternative strategies can be evaluated with respect to their degree of information sensitivity. The value of perfect information for each of the input variables can be assessed. The expected value of perfect information (EVPI) thus calculated represents the maximum value, in terms of the CD measure of effectiveness, that additional information is worth to the local CD system. Thus, a quantitative measure of information and modeling sensitivity is a by-product of the use of decision analysis in the evaluation module.

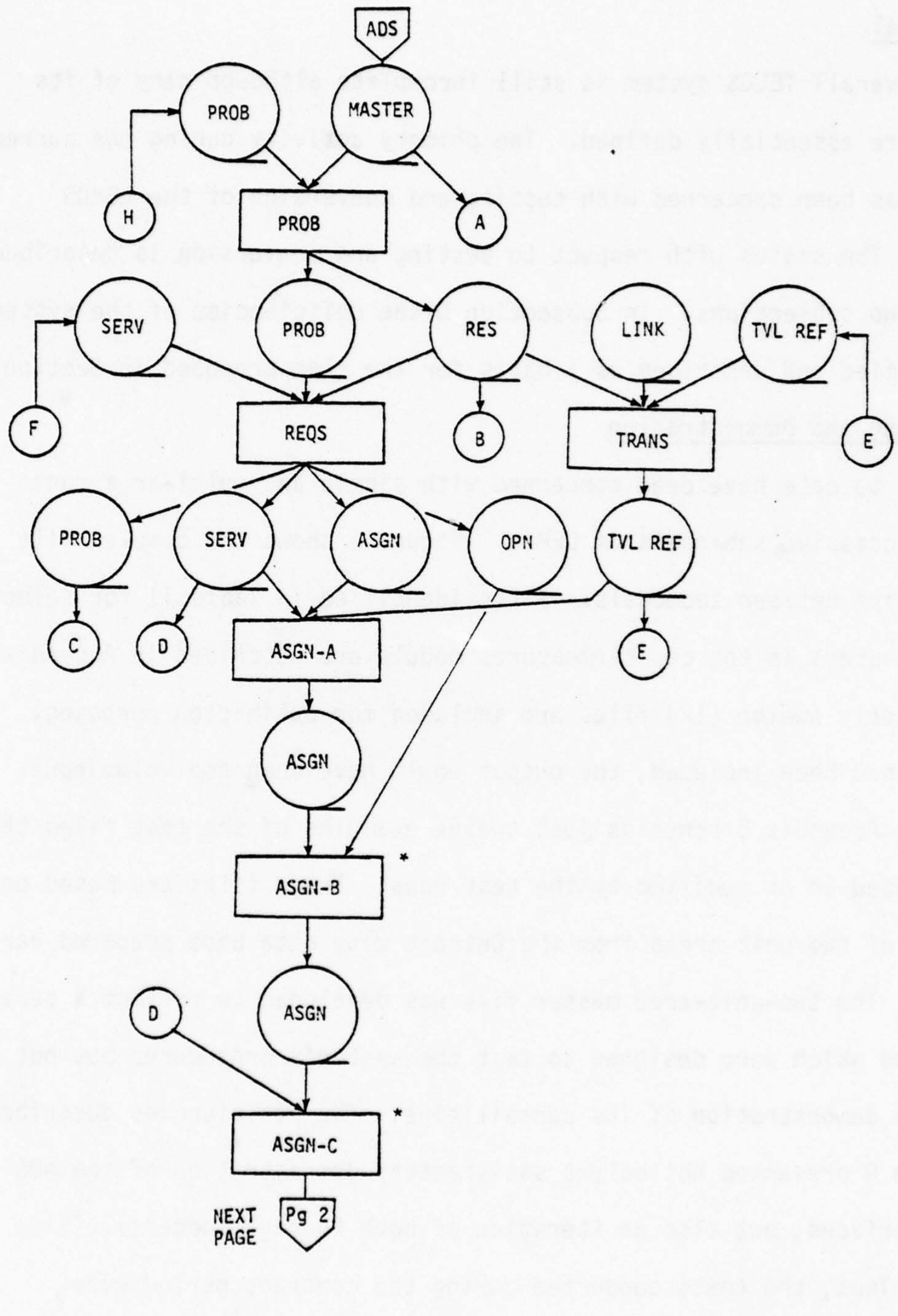
In summary, the decision analysis component of the system evaluation provides a logical tool to access CD emergency operation alternatives and the value of perfect information to local CD systems. When coupled with the sensitivity and value analysis components of the evaluation module, a comprehensive methodology exists for evaluating local CD systems, plans, and policies using the TELOS models.

A. General

The overall TELOS system is still incomplete although many of its elements are essentially defined. The primary activity during the current contract has been concerned with testing and conversion of the LEMOS elements. The status with respect to testing and conversion is described in the next two subsections. In Subsection D the deficiencies of the system are identified and described as a basis for the plan proposed in Section IV.

B. Testing and Demonstration

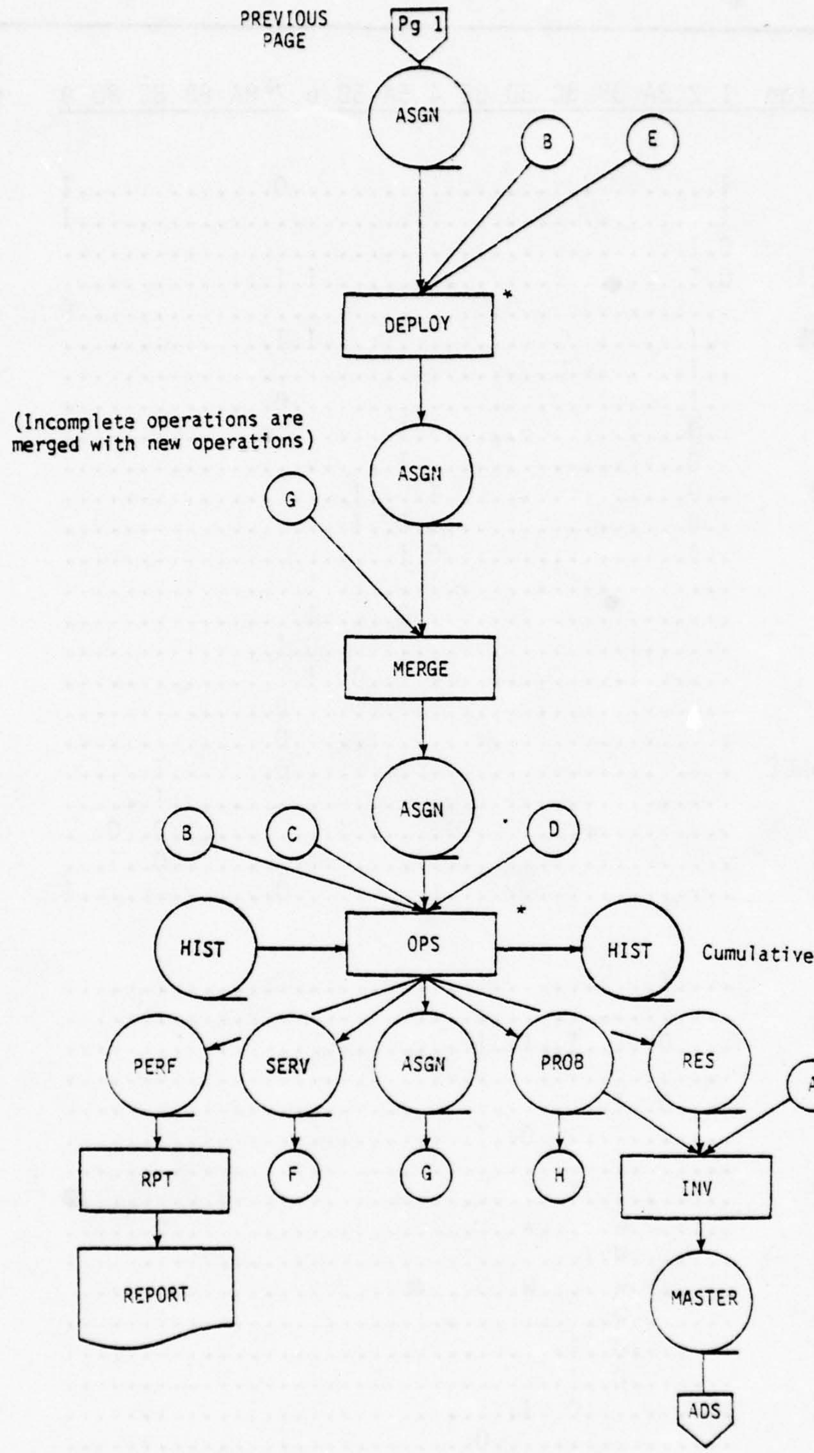
Tests to date have been concerned with single and multi-area runs through successive submodels of LEMOS. Figure 6 shows the complex file relationships between submodels. Files identified in Table II for selected successive steps in the countermeasures module are described in Appendix A. Note that only twelve (12) files are included for exhibition purposes. If all files had been included, the output would have been too voluminous. Therefore, Appendix B contains just twelve examples of the test files that were operated on or modified by the test runs. These files are based on the selection of two unit areas from the Detroit city data base prepared earlier [Ref. 2]. The two-unit-area master file was developed to reflect a series of problems which were designed to test the system's procedures but not to serve as a demonstration of its capabilities. The deficiencies described in Subsection D prevented not only a satisfactory demonstration of the ADS and LEMOS interfaces, but also an iteration of both through successive time periods. Thus, the tests conducted during the contract period were undertaken to demonstrate the unity and effectiveness of the file management



*Sorts have been omitted

(Continued)

Figure 6. LEMOS Data Flow



*Sorts have been omitted

Figure 6. LEMOS Data Flow (Continued)

TABLE II. FILE RELATIONSHIPS

DDNAME	Description	1	2	3A	3B	3C	3D	3E	4	5A	5B	6	7	8A	8B	8C	8D	9	Sample Files*
Cobol																			
FILE1	PROB1	I											O					I	
FILE2	MASTER1	I																I	1
FILE3	PROB2	O	I																
FILE4	RESOURCE1	O	I									I	I						2
FILE5	MASTER2																	O	
FILE6	REFERENCE		I									I	I						3
FILE12	ORGN		I																
FILE13	SERVICE1		I										O						
FILE15	OPS1		O							I									4
FILE16	PROB3		O							I									5
FILE19	SERVICE2		O						I		I								6
FILE20	ASGN1		O						I	O	I								7
FILE21	ASGN2		I						O	I									
FILE22	TVLREF								I			I							
FILE23	OPS2									O		I							
FILE25	TRIP											O	I						
FILE26	ASGN3										O	I							
FILE27	ASGN4												O						
FILE31	HISTORY												O						
FILE32	PERFORMANCE												O			I			8
FILE34	PLOT1															I			
FILE35	PLOT2															O	O		
FILE36	BENEFITS															O	I		9
FILE44	RESOURCE												O					I	10
Fortran																			
FT01F001	SYSIN			I															
FT03F001	SYSOUT=A																		
FT30F001	NETLIST			O	I	I	I	I											
FT51F001	LINKS			I															11
FT53F001	PATHS			O	I														
FT55F001	FINAL						O	I											
FT60F001	WORK																		
FT61F001	RESOURCE					I													
FT70F001	WORK				W		W												
FT71F001	WORK				W														
FT80F001	WORK				W		W												
FT81F001	TEMP				W														
FT91F001	A2BOUN				O	I													
FT92F001	BOUN2B				O	I													
FT93F001	DISTANCE					O	I												
FT94F001	TVLREF							O											12

*Appendix B contains the 12 identified examples of the test files.

and main model overlay procedures and not to serve as a formal demonstration of one or more of the roles for the system set forth in Section I, page I-3. These tests are believed to show that the currently designed elements have now been merged into an integrated system on the DCPACC's UNIVAC 1100/10 computer. However, even though they have been integrated, the system cannot be said to be operational. Operational status cannot be achieved until some, but not necessarily all, of the deficiencies described in Subsection D are resolved.

C. Conversion

All existing modules and submodels described in the previous section have been converted to operate on the UNIVAC 1100/10 computer at Olney, Maryland. That is, the same multi-area test runs have been successfully made on that machine. The files included in Appendix B were developed on the IBM 370/165 at the Triangle Universities Computation Center. They were used to confirm that the conversion to the UNIVAC 1100/10 was complete when these same outputs were produced by similar runs at DCPACC.

D. Deficiencies

A number of deficiencies remain to be overcome before the TELOS system can be said to be usable. The following list identifies the more significant shortcomings of the present system.

- Scenario Module
- Evaluation Module
- Data Base for GENUA and LEMOS
- Damage Functions for CD Resources
- Damage Assessment in ADS for CD Resources

- Fire Model in ADS
- Utility Network Model in LEMOS
- Self-Help Countermeasures
- Communications Submodel in LEMOS
- Queuing Submodel to Define Congestion Problems
- Preattack Operating Plans in LEMOS
- Reference Files for LEMOS

Each of the above deficiencies will be discussed in the following paragraphs and related to the overall program plan in Section IV.

1. Scenario Module

This important module is fragmented and incomplete. Its functions are now implemented in part by interactive methods within GENUA, LOCATE, ADS, and Pgm 0 (for LEMOS). All interactive inputs should be consolidated into a single module defined as the scenario module. Moreover, this module should be linked with the evaluation module to insure that a complete analysis of local operations will yield results which are consistent with the role chosen for TELOS.

2. Evaluation Module

Both ADS and LEMOS are capable of yielding a large number of outputs for a single time period, still more for multiple time periods within a single scenario, and enormous amounts of data for alternative scenarios. Therefore, an evaluation module is needed which will plan the scenario set, process the outputs and provide sufficient summary data to permit the user to achieve his

objectives. Since there are four potential roles for TELOS as described in Section I, page I-3, it may be necessary to have up to four different versions of the evaluation module depending on the roles being played. A plan for the development of this module(s) should be prepared after careful analysis of the capabilities of the other modules. This analysis may uncover additional deficiencies not included in this subsection.

3. Data Base for GENUA and LEMOS

A set of files should be prepared to support the GENUA module in such a way as to minimize the amount of effort required to generate an initial array of unit areas and resource records. These files should not attempt to describe every unit area explicitly, but rather contain generic land use class and population data which would allow the implicit development of each area. Interactive graphic methods should be used to create network overlays for highway and utility data. Once a generic description has been prepared from file data, the user can interact graphically with the layout and alter the implicitly developed array with explicit changes to agree with scenario requirements. Very little has been done to prepare this data base in a useful form. However, many of the data elements required for this file are available. A complete data base is not needed until a complete TELOS system has been developed and approved for operational use in one or more roles. Even though a complete data base is not required at this time, its requirements must be

defined in detail and a plan prepared to insure its compatibility with the system.

4. Damage Functions For CD Resources

The damage functions for general land use structure types and personnel casualties have been prepared for use in ADS. Damage functions for other resources are being prepared under Contract No. DCPA01-78-C-0298 with RTI. Some typical damage functions which are needed include those for:

- Bridges
- Vehicles
- Radio Transmitters/Receivers/Towers
- Telephone and Power Lines
- Telephone Exchanges
- Power Plants
- Gas Gates
- Water Pumping Stations

5. Damage Assessment in ADS for CD Resources

ADS needs to be modified to accommodate the damage functions described above and to enable assessment of damage to CD resources. These resources, including teams, are identified in the MSF on records with Code "5". ADS does not now process these records and some additions to its main program and subroutines will be required to process a complete MSF. This may be accomplished as a part of the DCPA01-78-C-0298 contract if time and funds permit.

6. Fire Model in ADS

The present fire model in ADS is an oversimplified representation of the fire spread situation. Fire cannot spread across a unit area boundary nor is there any relationship between highways and other potential fire breaks. The model developed by the Illinois Institute of Technology Research Institute (IITRI) and modified by the Institute for Defense Analysis (IDA) could be adapted to this role.

7. Utility Network Model in LEMOS

A flow model is needed as a part of the countermeasures model to determine the state of essential utilities, i.e., water, power, telephone, and sewage treatment. It is important to know the capabilities of these systems in order to implement an effective countermeasures plan.

8. Self-Help Countermeasures

These informal actions in response to problems involving people who are almost totally divorced from the formal civil defense system must be taken into account in measuring the performance of the formal civil defense organization. These actions are not presently evaluated in LEMOS.

Problems can be solved wholly or partially by individuals without help from the system. A person trapped in a damaged building may be rescued by another person and taken to an adjacent undamaged shelter simply because he sees a problem and has the capability to solve it immediately. This type of countermeasure

is spontaneous and assumes that no control is exercised. Other self-help actions interface directly with formal civil defense actions. On hearing a warning siren, people respond in various ways (e.g., ignore, duck, move, or enter shelter) if no other controls exist. Similarly, the emergency broadcast system (EBS) may provide a stimulus for popular action which is basically uncontrolled. Prediction of uncontrolled responses is largely probabilistic and often based on experimental statistics. In order to consider these factors, a set of self-help functions that process the defined problems and change the magnitude of each according to the response predicted by the function is needed. Only immediate responses are allowed. No long term coordinated actions outside of the civil defense system are allowed. Even though they may occur, no dual civil defense system is likely to increase system effectiveness.

The outcome of self-help countermeasures is a revised set of problems which enter the information system.

9. Communications Submodel in LEMOS

All problems are assumed to be identified as they enter the communications submodel. Reports are generated by origin or unit area and a priority is attached to each. They are assigned to communication terminal queues at responsible control team locations. In addition, each report or message is addressed according to the organizational structure. Policy constraints influence both the priority and the address of assignments to

specific classes of reports. Reports may enter the organization at any level subject to policy control.

The communication submodel manages the information flow by locating, classifying, addressing, and assigning priority to all problems.

Time delays or blockages introduced by message flow through the network constrains the timeliness of system response.

The physical characteristics of the communication network and operating teams are defined from target model elements. The state of each link, including both terminals, is determined from damage assessment model outputs.

Message loads are developed by propagating messages from terminal queues over the network during the time interval according to the general operating policy. Message batches are processed by precedence. When mode handling time plus link processing time is less than the time interval, propagation of the batch is continued. If channel capacity is reached, the message batch is split and an alternate route is selected. If the queue limit is reached, the next alternate route is selected when the load has progressed as far as possible in the time interval. All messages are stored in queues; when a terminal is reached by the load, the load is removed from the traffic.

A communication module is needed to assist in developing and evaluating communication plans (by state and local authorities). The communication plans must be considered as a central part of

the overall zonal plans for command and control. This effort will build upon the results of previous efforts [Ref. 24] and will relate to the planning role for TELOS. The design and implemented model should include the following elements or attributes.

- A description of the preattack and postattack communications network.
- A description of the essential team operations, personnel, and resources required to implement the communication system.
- The necessary and sufficient elements of an effective "communications plan" must be described as it may interface with the TELOS system.
- The vulnerability and evaluation criteria are needed to measure planning effectiveness.
- The design of an overall communications model must be capable of measuring the performance of alternative sets of local communication system resources under nuclear attack, evaluating the relative degradation among the alternatives and determining the impact of various levels of communication system degradation on overall system effectiveness.

10. Queuing Submodel to Define Congestion Effects

While routes and travel times are defined in the transportation submodel, movements are accomplished without considering traffic congestion and its effect on travel times. A queuing submodel

could determine these effects and their impact on countermeasure operations.

Basically, a trip is defined as a move in which some resource takes a path (represented by the link) through an environment. The link has four properties: (1) a gate which processes trips one at a time, (2) a queue which orders the trips through the gate, (3) a pointer which guides the trip to other links, and (4) a generator which originates new trips for the networks.

Using the queuing model and the trip file, resources are moved over the network. Starting with the highest level network, movement proceeds until all are at the lowest (or the unit area) level. Unforeseen delays require that arrival times be adjusted for positions attained during the time interval. Statistics are prepared for each link. Information from this queuing process will be used for planning movements during the next time interval. Thus, decisions are being influenced constantly by events in the immediate past. (Correspondingly, fallout prediction data could be made to influence routing by formulating predictions in a way similar to that described above). Deployment is completed to determine arrival times for teams performing assigned functions.

11. Preattack Operating Plans in LEMOS

No provision is made in LEMOS for incorporating preattack mobilization, deployment, crisis relocation or community shelter plans. LEMOS responds to transattack problems and not to anticipated problems. However, the present code may be adapted to

include a full range of such problems provided a triggering mechanism is employed to determine the time to respond to the anticipated problems. In addition, new inputs reflecting these plans must be structured and prepared. This deficiency is perhaps one of the more important shortcomings of the LEMOS system and should be corrected as early as practicable.

12. Reference Files for LEMOS

Certain inherent characteristics of civil defense operations are defined in a series of tables; for example, the components of teams, alternative operations, or consumption rates of resources by active teams. The present reference files contain data which was collected quickly to function as a test of the operating system. More care is needed in researching available civil defense reports for the best data together with some estimate of the maximum or minimum values that could be used to represent the data element. Again, this is another important deficiency that needs early resolution.

All of the above-described deficiencies should be recognized and a plan created to correct each according to its importance with respect to the roles planned for the system. Section IV suggests a program schedule for eliminating these deficiencies and developing an operational TELOS simulation. While these deficiencies appear to be numerous, they represent a relatively small part of the total TELOS system.

A. General

This section is a logical extension of the previous section and attempts to summarize the development status in terms of a program plan which will lead to the implementation of all four roles described in Section I, page I-3.

B. Research Role

Assuming that TELOS in the research role is adopted as a basic system, Table III shows a development plan in terms of person-years of effort to complete each module and submodel within TELOS for each prospective application. The other roles build upon this basic system.

C. National Readiness Assessment Role

A second role for TELOS could be national assessment of civil defense readiness. This extension would require an expanded data base, an interface with a readiness reporting system, and an interface with a national assessment system using ANCET or similar rapid means for relating resource degradation directly to weapons effects.

D. Planning Role

The third role for TELOS is as a tool for local civil defense planners. Since each local CD planner is responsible for his plans, TELOS cannot assume the evaluative role for him. Therefore, the outcome interface must contain several alternative means for evaluating simulation outcomes as they may be influenced by local plans. The planner should have not only the choice from among these alternatives but should be able to "tune" the selected method to meet his objectives wherever practicable. Measures for normalizing outcome measures are especially important.

TABLE III. PROGRAM DEVELOPMENT PLAN

	Person-Years of Effort for Each TELOS Role			
	Research	National Assessment	Planning	Training
SCENARIO	0.5	1.0$^{\Delta}$	1.5	1.0
TARGET (GENUA)				
Test Zone Data Base	0.5*			
Generic Data Base		1.0	0.5	1.5
ATTACK (LOCATE)				
Risk		0.5	1.0	1.0
DAMAGE ASSESSMENT (ADS)				
Resource Damage Function	1.0§			
Resource Damage Assessment	0.5			
Fire Model		1.0	0.5	0.5
COUNTERMEASURE (LEMOS)				
Communication Submodel	1.0*			
Utility Network Submodel	0.5			
Queuing Submodel		1.0		
Operating Plans			2.0	
Reference Files			0.5	0.5
EVALUATION	1.0	0.5	1.5	1.5
DOCUMENTATION/TESTING	1.0*	1.5	2.0	2.0
TOTAL	6.0	6.5	9.5	8.0

$^{\Delta}$Assumes use of ANCET.
§Currently funded by Contract No. DCPA01-78-C-0298.
*Detailed tasks identified by DCPA for the next effort for probable funding.

The previous section contained an approach to systems evaluation which offers a rational means for improving local operations through computer simulation. Additional measures or evaluative techniques may be developed if the local planner considers them essential to the proper evaluation of his plans.

This role requires an explicit means for entering local plans in the simulation model and developing revised plans from outcomes, a generalized data base from which local target models can be efficiently generated, and interactive methods for the planner's participation in the process.

Perhaps the greatest impact of the TELOS system can be achieved by fielding mobile remote terminal units that can bring direct computer aided planning to the local level. Obviously, this would bring a degree of public visibility to civil defense, but, more importantly, it would bring to local personnel the most advanced and objective techniques for planning the optimum utilization of available resources. A number of such units following carefully scheduled itineraries could cover the United States in a systematic fashion and develop a reliable data base for national planning. Plans evolving from these contacts at each locality could achieve a high degree of standardization, and yet allow for local unique differences. Microprocessors in the mobile unit can minimize the effort required to convert computer outputs to detailed local operating plans.

E. Training Role

Once the other roles have been implemented, the training role requires slightly less additional effort than for the planning role to adapt the

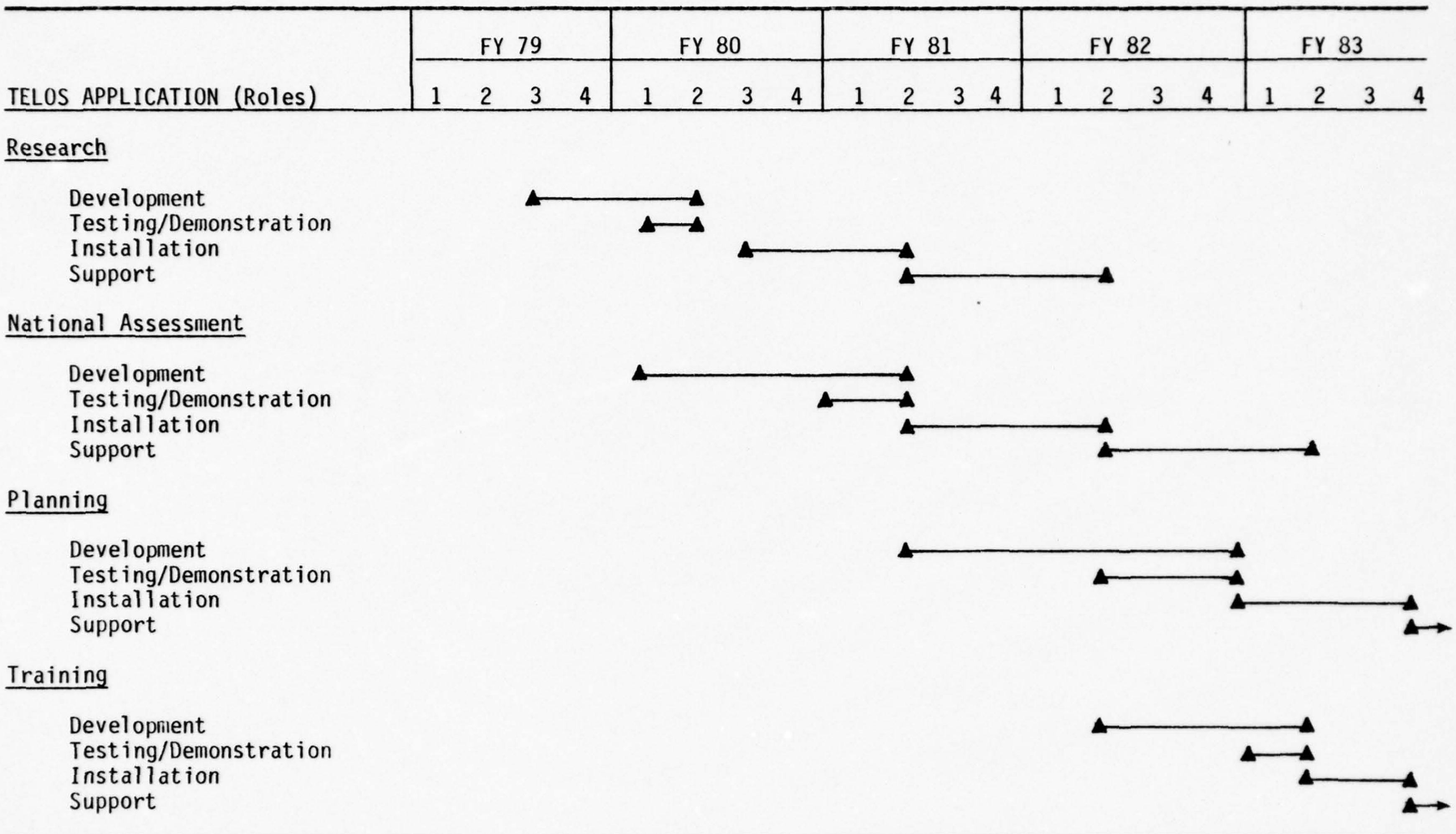
system to the training role. The training acquired by local participants would be valuable in stimulating interest and improving direction and control of local operations. The mobile units would have capability for both remote interactive development of operational scenarios and batch generation of timephased computer outputs.

The major additions to the system would focus on the computer graphics as a means for improving communications between the trainee and system and on the development of a set of scenarios including specific target areas where outcomes illustrate the main points to be learned by exercising the system [Ref. 25]. Under these conditions, this simulation tool could become a major asset of the CD training center at Battle Creek, Michigan.

F. Development Schedule

Assuming that the local simulation is capable of fulfilling the roles defined in the previous subsection, Table IV describes a set of phases, including development, test and demonstration, installation and support for each role. The installation phase assumes that some modifications of the demonstrated system are required as a result of the demonstration to meet specific user requirements. The overall plan implies that each subsequent role builds upon the product of the previous effort.

TABLE IV. PROGRAM SCHEDULE



The approach to the development of a system evaluation methodology is considered to be of primary importance, if the TELOS system is to become an important tool in improving local civil defense operations. Now that the capabilities of a prototype TELOS system are clearly delineated, it is appropriate at this time to structure an evaluation module that will utilize the TELOS code to best advantage. While the code is being tested, refined, and demonstrated, the evaluation methodology should be formalized so that appropriate inputs and outputs can be assured. A project for this development has been added to the program plan in Section IV as a means for integrating the evaluation module into TELOS procedures. This activity should be concurrent with the documentation, test, and demonstration activities currently planned for TELOS.

Now that the TELOS system has been converted to the UNIVAC 1100/10 environment and is available for interactive use by the Research Directorate and its contractor through remote or foreign terminals, it is propitious to document thoroughly, test present code and correct deficiencies as well as fill some of the analytical voids now apparent in the system. Standards for this documentation [Ref. 26] are available but require explicit decisions in order to meet DCPACC and user needs as well as those of the Research Directorate and its contractor, RTI. Assuming mid-range total level of complexity based on the twelve factors for assessing complexity in the DOD standard cited above, the documentation should contain the following document types: a functional description (FD), a Users Manual (UM), a Computer Operation Manual (OM), a Program Maintenance Manual (MM), and a

Test Plan (TP). The standard contains an outline of each of these documents and these outlines are reproduced in Appendix C. However, the standard allows considerable latitude depending upon the ADP center's needs and desires. Therefore, it is important that DCPACC establishes the final outlines of these documents and that they are developed in the next phase of the TELOS development program.

The program plan described in Section IV offers a comprehensive approach to achieving the roles described for TELOS. While this plan is believed to be technically feasible, RTI has no way of determining whether it can be implemented within funding constraints nor whether it can be integrated with user program plans. It is important that the entire TELOS concept, including evaluation and user roles, be validated as a part of DCPA program planning.

Among the LEMOS deficiencies described in Section III, the communication submodel is considered to be the most significant void to be filled next. The impact of the submodel in command and control is very important and should not be underestimated. This development should be based on work discontinued at RTI some years ago [Ref. 24].

Finally, the priorities attached to each line item in the program plan need to be determined. RTI has included in the next section its conclusions and recommendations for further development of the TELOS concept. These conclusions and recommendations are based on its assessment of relative importance in achieving the goal of a basic research tool which can be adapted to the other roles, if DCPA determines that the roles need to be implemented.

Based on the test and conversion activities performed during Contract DCPA01-77-C-0238, RTI concludes that:

- Further development of LEMOS should be carried out on the UNIVAC 1100/10 using its remote terminal facilities.
- Detailed documentation, including a test plan, should be prepared before further testing is conducted or case studies are performed.
- Extension to the TELOS system, particularly the communications submodel, must be undertaken and must be consistent with the overall development plan and evaluation methodology.
- The development of the evaluation module methodology as outlined herein should be started immediately.

RTI recommends that:

- Preparation of TELOS documentation become the basis for further system development and testing.
- The program plan for realizing the full potential be validated.
- The next element within LEMOS to be developed be the communications submodel.
- The methodology for local operating system evaluation using the present TELOS structure be initiated with high priority.

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FILE

DESCRIPTIONS

The descriptions in this Appendix will be identified by the basic name in the description column. The following files are described briefly in subsequent paragraphs. Each of these files are included in Appendix B except for History, Performance, Plot and Benefits. These files are believed to be inadequate until ADS is made compatible to the operations submodel by resolving the issue as to which submodel decides when the deaths occur for casualties.

- Reference (REFERENCE)
- Master Status (MSF-2)
- Problem (PROBL-3)
- Resource (RES)
- Service (SERV-2)
- Operations (OPS1-2)
- Assignment (ASGN1-4)
- History (HIST)
- Performance (PERF)
- Plot (PLOT1-2)
- Benefits (BEN)
- Links (LINKS)
- Travel (TVLREF)

- Reference File

The Reference File contains a series of tables which represent basic reference material (on operations, functions, and teams) required to quantify the simulated operations. An Alternative Table produces a set of alternative operations given a specific problem. The Operations Table defines the specific functions which constitute the operation. A Function Table indicates the teams which can perform that function together with their relative

efficiency. The characteristics of each team are contained in the Team Table, which along with the Work Table, enables the user to compute team-hour and resource requirements for functional performance to resolve problems. This file may be modified at the beginning of a simulation, but should not be changed during the time frame of the scenario.

- Master Status File (MSF)

The Master Status File represents the target model in terms of area, structures, shelter, people, and other special resources. Each of these elements is classified by types and status. Quantities in the MSF record fields are changed in the Area Damage System (ADS) model to reflect target degradation. The object of the LEMOS model is to upgrage resource states using various functional countermeasures, or at least to prevent further degradation by fire and fallout. This file is a primary communication vehicle between ADS and LEMOS and between time periods. At the present time, ADS has not been modified to process the special resources portion of the MSF.

- Problem File (PROB)

The Problem File defines problems by unit area which must be resolved by the available countermeasures. Four general problem types are recognized: control, readiness, damage, and relief and rehabilitation. The objective of local operations is to resolve each of these problems as soon as practicable.

- Resource File (RES)

The Resource File quantifies the resources by unit area and provides a means for accounting for the essential elements of the MSF during countermeasure processing. Emphasis is placed on tracking personnel and CD teams.

- Service File (SERV)

The Service File is required to maintain information about the teams and the services to which the team belong. It is used in the Requirement Program (PGM2) to define readiness problems. The status of each team is determined in the Operations Program (PGM7). This represents a primary feedback on the status of Civil Defense teams.

- Operations File (OPS)

The Operations File contains a record for each selected operation in terms of the specific functions needed to resolve the problem. In addition, this record contains information about quantities, start time, benefits, priorities, and related subjects.

- Assignment File (ASGN)

Each function is represented by a record in the Assignment File on which the operation is identified, the number of teams assigned, the start time determined, and the amount of effort expressed in team-hours to produce the desired result. The operations and assignment are mixed within Program 5 after a specific operation is selected.

Where movement of resources (including people requiring aid, or CD teams and material to provide aid) are required, trip records are prepared within the assignment file giving origin and destinations as well as start and arrival times; one trip record for the unit area in which the move originates, and the second for the unit area in which the move terminates. After sorting between Programs 6 and 7, these records are used to subtract resources from one area to another area to accomplish the deployment.

- History File (HIST)

The assignments are executed in the Operations Program (PGM7) by expending resources and deriving benefits. These transactions are recorded on the assignment records and, if desired, retained for historical analysis. All retained assignment records are contained in the History File. In most cases, the History File would not be retained.

- Performance File (PERF)

Data from the Performance File is analyzed in the Report Generator and tabular Benefit and Readiness Reports prepared in the Report Generation Program (PGM8). This program updates the Plot File.

- Plot File (PLOT)

Values of key performance measures are retained from the Performance File in the Plot File for time plots at designated breaks in the scenario. Normally, these breaks occur when interactive sessions are planned to evaluate intermediate results and, perhaps, change priorities, prohibitions, or limitations used to control the scenario.

- Links File (LINKS)

The Links File contains information about the highway system by which unit areas are linked and over which resources are moved. The damage assessment system does not process this file at the present time. However, provision should be made at a later date to determine damage to the highway network (particularly to bridges in it). Nevertheless, some consideration is given to weapons effects by using the Basic Operating Situation (BOS) designations from the Resource File.

- Travel Reference File (TVLREC)

The analysis of the transportation network defined by the Links File in Floyd's algorithm leads to the preparation of the Travel Reference File containing measures of average travel time between all origins and destinations in terms of unit areas. These referece travel time values are used to select assignments in the assignment subsystem and prepare trip records in the Deployment Program. Redefinition of this file depends on changes in the BOS for each unit area. However, it may not be necessary to redefine it for each time period unless significant changes have occurred (e.g., another weapon detonates or severe environmental changes occur in many unit areas).

Specific formats for records in these files are contained in Appendix B along with the test data records used to verify proper conversion at DCPACC.

CONVERSION RESULTS

AND

TEST FILES

A. Compilation Results

The major step in accomplishing conversion of the LEMOS system to the UNIVAC 1100/10 computer at DCPACC involved the necessary changes in the source code to obtain successful ASCII (American National Standard Code for Information Interchange) compilations. The programs were originally developed on the IBM 370/165 compiler at the Triangle Universities Computation Center and thus contained some IBM extensions that are not elements of the ASCII versions of COBOL and FORTRAN. Program changes were made and information extracted from the compilations is given below that shows the successful completion of this phase of the conversion.

RESMAIN

ACOB 4R2 R SL73R1 05/14/79 12:10:20 (18,) 1100 ASCII COBOL 02/06/79 17:46

(listing)

END ACOB DIAGNOSTIC TOTALS 0 WARNING 0 MINOR 0 SERIOUS 0 FATAL 0 LEVELING
COMPLETE TIME IS 17.60 SECONDS CORE: MIN= 54174/54784 MAX= 55296 WORDS

DCPASORT

ACOB 4R2 R SL73R1 05/02/79 09:54:45 (19,) 1100 ASCII COBOL 02/06/79 17:46

(listing)

END ACOB DIAGNOSTIC TOTALS 1 WARNING 3 MINOR 0 SERIOUS 0 FATAL 0 LEVELING
COMPILE TIME IS 18.94 SECONDS CORE: MIN= 54174/54784 MAX= 54784 WORDS

NGM1

ACOB 4R2 R SL73R1 03/28/79 17:10:46 (53,) 1100 ASCII COBOL 02/06/79 17:46

(listing)

END ACOB DIAGNOSTIC TOTALS 4 WARNING 0 MINOR 0 SERIOUS 0 FATAL 0 LEVELING
COMPILE TIME IS 151.51 SECONDS CORE: MIN= 54174/54784 MAX= 55296 WORDS

NGM2

ACOB 4R2 R SL73R1 05/29/79 14:24:55 (31,) 1100 ASCII COBOL 02/06/79 17:46

(listing)

END ACOB DIAGNOSTIC TOTALS 16 WARNING 0 MINOR 0 SERIOUS 0 FATAL 0 LEVELING
COMPILE TIME IS 103.82 SECONDS CORE: MIN= 54174/54784 MAX= 55808 WORDS

NGM3 series (A, B, C, D, E)

These programs, written in IBM/370 FORTRAN IV, are, in some cases, incompatible with ASCII FORTRAN. Therefore, conversion of these programs was not completed prior to project termination.

NGM4

ACOB 4R2 R SL73R1 05/29/79 14:22:15 (20,) 1100 ASCII COBOL 02/06/79 17:46

(listing)

END ACOB DIAGNOSTIC TOTALS 6 WARNING 0 MINOR 0 SERIOUS 0 FATAL 0 LEVELING
COMPILE TIME IS 49.72 SECONDS CORE: MIN= 54174/54784 MAX= 55296 WORDS

NGM5

ACOB 4R2 R SL73R1 04/30/79 11:15:23 (5,) 1100 ASCII COBOL 02/06/79 17:46

(listing)

END ACOB DIAGNOSTIC TOTALS 12 WARNING 0 MINOR 0 SERIOUS 0 FATAL 0 LEVELING
COMPILE TIME IS 109.35 SECONDS CORE: MIN= 54174/54784 MAX= 55296 WORDS

NGM6

ACOB 4R2 R SL73R1 05/29/79 16:53:33 (3,) 1100 ASCII COBOL 02/06/79 17:46

(listing)

END ACOB DIAGNOSTIC TOTALS 23 WARNING 0 MINOR 0 SERIOUS 0 FATAL 0 LEVELING
COMPILE TIME IS 137.14 SECONDS CORE: MIN= 54174/54784 MAX= 55808 WORDS

NGM7

ACOB 4R2 R SL73R1 05/01/79 10:58:46 (3,) 1100 ASCII COBOL 02/06/79 17:46

(listing)

END ACOB DIAGNOSTIC TOTALS 11 WARNING 0 MINOR 0 SERIOUS 0 FATAL 0 LEVELING
COMPILE TIME IS 140.55 SECONDS CORE: MIN= 54174/54784 MAX= 55808 WORDS

NGM8

ACOB 4R2 R SL73R1 05/14/79 1:50:59 (6,) 1100 ASCII COBOL 02/06/79 17:46

(listing)

END ACOB DIAGNOSTIC TOTALS 14 WARNING 0 MINOR 0 SERIOUS 0 FATAL 0 LEVELING
COMPILE TIME IS 101.86 SECONDS CORE: MIN= 54174/54784 MAX= 55296 WORDS

NGM9

ACOB 4R2 R SL73R1 05/14/79 11:53:38 (11,) 1100 ASCII COBOL 02/06/79 17:46

(listing)

END ACOB DIAGNOSTIC TOTALS 12 WARNING 0 MINOR 0 SERIOUS 0 FATAL 0 LEVELING
COMPILE TIME IS 167.68 SECONDS CORE: MIN= 54174/54784 MAX= 55296 WORDS

B. File Examples

After the LEMOS programs were compiled, a number of the resulting relocatable elements were mapped together to produce an absolute (executable) element. Using this absolute element, most test files involved in LEMOS were produced, although unforeseen delays prevented generation of the History, Performance, Plot, and Benefit Files. Figures B-1 through B-6 present partial listings of six of the thirteen major LEMOS files, which are listed in Appendix A. Format descriptions of these files are given in the following subsections.

```
10000000000000003000014243108310700061456180901000100020013000302205259001579500
20000000000000003111310022001312000000000000000000000000000000000000000000000000
20000000000000003111321022001312000000000000000000000000000000000000000000000000
20000000000000003111411122001311000000000000000000000000000000000000000000000000
20000000000000003111421222000000001311000000000000000000000000000000000000000000
20000000000000003112312022000000000000001311000000000000000000000000000000000000
20000000000000003112322222000000000000000000001311000000000000000000000000000000
20000000000000003112410022001311000000000000000000000000000000000000000000000000
20000000000000003112420022001311000000000000000000000000000000000000000000000000
20000000000000003481310022000499000000000000000000000000000000000000000000000000
20000000000000003481321022000499000000000000000000000000000000000000000000000000
20000000000000003481411122000499000000000000000000000000000000000000000000000000
20000000000000003481421222000000049900000000000000000000000000000000000000000000
20000000000000003482312022000000000000049900000000000000000000000000000000000000
20000000000000003482322222000000000000000000004990000000000000000000000000000000
20000000000000003482410022000499000000000000000000000000000000000000000000000000
20000000000000003482420022000499000000000000000000000000000000000000000000000000
20000000000000003491310000000349000000000000000000000000000000000000000000000000
20000000000000003491320000000349000000000000000000000000000000000000000000000000
20000000000000003491410000000349000000000000000000000000000000000000000000000000
20000000000000003491420000000349000000000000000000000000000000000000000000000000
20000000000000003492310000000348000000000000000000000000000000000000000000000000
20000000000000003492320000000348000000000000000000000000000000000000000000000000
20000000000000003492410000000348000000000000000000000000000000000000000000000000
20000000000000003492420000000348000000000000000000000000000000000000000000000000
20000000000000003591310022000250000000000000000000000000000000000000000000000000
20000000000000003591321022000250000000000000000000000000000000000000000000000000
20000000000000003591411122000250000000000000000000000000000000000000000000000000
20000000000000003591421222000000025000000000000000000000000000000000000000000000
20000000000000003592312022000000000000025000000000000000000000000000000000000000
20000000000000003592322222000000000000000000002500000000000000000000000000000000
20000000000000003592410022000250000000000000000000000000000000000000000000000000
20000000000000003592420022000250000000000000000000000000000000000000000000000000
20000000000000003611310000000100000000000000000000000000000000000000000000000000
20000000000000003661310000000150000000000000000000000000000000000000000000000000
20000000000000003661320000000150000000000000000000000000000000000000000000000000
20000000000000003661410000000150000000000000000000000000000000000000000000000000
20000000000000003661420000000150000000000000000000000000000000000000000000000000
20000000000000003662310000000150000000000000000000000000000000000000000000000000
20000000000000003662320000000150000000000000000000000000000000000000000000000000
20000000000000003662410000000150000000000000000000000000000000000000000000000000
20000000000000003662420000000150000000000000000000000000000000000000000000000000
30000000000000003111310000010099010000000000000000000000000000000000000000000000
30000000000000003481310000010099010000000000000000000000000000000000000000000000
30000000000000003491310000010099010000000000000000000000000000000000000000000000
30000000000000003591310000197500131400010000000012170014230105000000000000000000
30000000000000003591320000197500131400010000000012170014230105000000000000000000
30000000000000003591410000197500131400010000000012170014230105000000000000000000
30000000000000003591420000197400131400010000000012170014230105000000000000000000
30000000000000003592310000197400131400010000000012170014230105000000000000000000
```


Figure B-1. Master Status File

```
4000031120 1000000000 000000000000100000000000000000000000000000000000000
4000031120 2000000000 000000000000000000000000000000000000000000005552000
4000031120 3420026221 251251250000000001049001049000200003000020000000
4000031121 4790043191 000099000000000000000000000000000120001800000000001
4000031121 4730006081 000099000000000000000000000000000120001800000000001
4000031122 4790006251 000099000000000000000000000000000120061808090703002
4000031122 4790000492 000099000000000000000000000000000120152508090703002
4000031122 4790000283 000099000000000000000000000000000120262808090703002
4000032220 1000000000 000000000000000000000000000000000000000000000000000
4000032220 2000000000 000000000000000000000000000000000000000000000800000
4000032220 3480000000 000000000000000000000000000000000000003000000000000
4000032221 4840008004 000000000000000000000000000000000000000000000000000
4000034820 1000000000 000000000000100000000000000000000000000000000000000
4000034820 2000000000 000000000000000000000000000000000000000000005552000
4000034820 3420054892 862862860000000000017465017465002000030000200000000
4000034821 4790043191 000099000000000000000000000000000120001800000000001
4000034821 4730006081 000099000000000000000000000000000120001800000000001
4000034822 4790006251 000099000000000000000000000000000120061808090703002
4000034822 4790000492 000099000000000000000000000000000120152508090703002
4000034822 4790000283 000099000000000000000000000000000120262808090703002
4000034920 1000000000 000000000000100000000000000000000000000000000000000
4000034920 2000000000 000000000000000000000000000000000000000000000000000
4000034920 3480000000 000000000000000000000278800278800000000300000000000
4000035220 1000000000 000000000000000000000000000000000000000000000000000
4000035220 2000000000 000000000000000000000000000000000000000000000000000
4000035220 3480000000 000000000000000000000000000000000000003000000000000
4000035920 1000000000 000000000001184700000000000000000000000000000000000
4000035920 2000000000 000000000000000000000000000000000000000000005544000
4000035920 3420027502 862862860000000000008750008750002000030000200000000
4000035921 4790048441 000000000000000000000990000000000000600007000000001
4000035922 4660007001 000000000000000000000990000000000000600207126300005002
4000036120 1000000000 000000000000000000000000000000000000000000000000000
4000036120 2000000000 000000000000000000000000000000000000000000000000000
4000036120 3480000000 000000000000000000000010000001000000003000000000000
4000141120 1000000000 000000000000100000000000000000000000000000000000000
4000141120 2000000000 000000000000000000000000000000000000000000000000000
4000140020 1000000000 000000000000000000000000000000000000000000000000000
4000140020 2000000000 000000000000000000000000000000000000000000000800000
4000140021 4940008004 000000000000000000000000000000000000000000000000000
4000144820 1000000000 000000000000100000000000000000000000000000000000000
4000144820 2000000000 000000000000000000000000000000000000000000000000000
4000144920 1000000000 000000000000100000000000000000000000000000000000000
4000144920 2000000000 000000000000000000000000000000000000000000000000000
4000145920 1000000000 000000000007510000000000000000000000000000000000000
4000145920 2000000000 000000000000000000000000000000000000000000000000000
4000146120 1000000000 000000000000100000000000000000000000000000000000000
4000146120 2000000000 000000000000000000000000000000000000000000000000000
```

Figure B-2. Problem File

```
40000311013400344010490005552000702000000000000000001000000000000000000000000000000000000000000000000000000000000070200492700000000000000000000000000
40000322013100111000000000800000000000080000000000000000000000000000000000000000000000000000000000000000000000000000000000000000800000000000015000
40000348018700055017465005552000702000000000000000000100000000000000000000000000000000000000000000000000000000070200492700000000000000000000000000
40000349013100006002788000000000000000000000000000000001000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
40000352013100000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
40000352023100000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
40000359018700000600875000554400070000000000000000118470000000000000000000000000000000000000000000000000000000000000700048440000000000000000000000000
40000361013100012000010000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
40001411013100139007836000000000000000000000000000000001000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
40001400013100000000000000008000000000000008000000000000000000000000000000000000000000000000000000000000000000000000000000000000800000000000000000
40001448013100040003685000000000000000000000000000000001000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
40001449013100004000466000000000000000000000000000000001000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
40001459013100012001000000000000000000000000000000007510000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
40001461013100028000010000000000000000000000000000000001000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
```

Figure B-3. Resource File

```
010101030740000031C00000000000000000000000000C00000000000000000000C0C0000000000000014000014000000000002369400C000000000000000000000000000000000
01C1010307400003110000000000C0000000000000000C0000000000000000000000000000000000010280800280800000000000050000C000000000000000000000000000000000
01C101030340C0032200C0000C000000000CC0000CCC000C00000000000C0C000000000000000000000015000000037600C00000C00000000000000000000000000000000000C
01C1010207400C0140700C0000C000000000C0C00000C0C000C00000000000C0C000000000000000000000000000000000000C10000C000000000000000000000000000000000C
010101020740C0141C00G0000C0C00000000000000000C00000000000000000000000000000000000000000000000000000751000C0000000000000000000000000C0000000
01C1010207400C01411000000C0000000000000000000C000000C00000000000000C000000000000001000000000000000000000C30000C000000000000000000000000300000000
```

Figure B-4. Service File

```
0101010340000314000031101237115000037000555200000310137000012000000000000000000000038000000000000000000C0000000000000000000
0101010340000314000031101479115000079000431900001040132000029303134370000000000000353940410000000000C0000000000000000000
0101010340000314000031101479215000079000431900000980135000029303137000000000000000034370000000000000C0000000000000000000
010101034000031400003110147922500007900043190000132000000003539404100000000000000000000000000000000C0000000000000000000
01010103400003140000311014793150000790004319000009901200002930370000000000000000000031370000000000000C0000000000000000000
01010103400003140000311014793250000790004319000013000000000343539404100000000000000000000000000000000C0000000000000000000
01010103400003140000311014794150000790004319000009901200002930370000000000000000000031370000000000000C0000000000000000000
0101010340000314000031101479425000079000431900001190000000313435394041000000000000000000000000000000C0000000000000000000
010101034000031400003110147951500007900043190000100111000029370000000000000000000303700000000000000C0000000000000000000
01010103400003140000311014795250000790004319000010800000003031343539404100000000000000000000000000000C0000000000000000000
010101034000031400003110147311500007300006080000075013200002729303134370000000000000003539404100000000C0000000000000000000
010101034000031400003110147321500007300006080000064013500002729303137000000000000000034370000000000000C0000000000000000000
010101034000031400003110147322500007300006080000132000000003539404100000000000000000000000000000000C0000000000000000000
0101010340000314000031101473315000073000060800000650120000272930370000000000000000031370000000000000C0000000000000000000
01010103400003140000311014733250000730000608000013000000000343539404100000000000000000000000000000000C0000000000000000000
010101034000031400003110147341500007300006080000066011100002729370000000000000000303700000000000000C0000000000000000000
0101010340000314000031101473425000073000060800001190000000313435394041000000000000000000000000000000C0000000000000000000
0101010340000314000031101473515000073000060800000880100000027000000000000000000000293700000000000000C0000000000000000000
01010103400003140000311014735250000730000608000010800000003031343539404100000000000000000000000000000C0000000000000000000
0101010340000314000031101479115000079000062500001040132000029303134370000000000000353940410000000000C0000000000000000000
0101010340000314000031101479215000079000062500000980135000029303137000000000000000034370000000000000C0000000000000000000
010101034000031400003110147922500007900006250000132000000003539404100000000000000000000000000000000C0000000000000000000
01010103400003140000311014793150000790000625000009901200002930370000000000000000000031370000000000000C0000000000000000000
01010103400003140000311014793250000790000625000013000000000343539404100000000000000000000000000000000C0000000000000000000
01010103400003140000311014794150000790000625000009901200002930370000000000000000000031370000000000000C0000000000000000000
0101010340000314000031101479425000079000062500001190000000313435394041000000000000000000000000000000C0000000000000000000
010101034000031400003110147951500007900006250000100111000029370000000000000000000303700000000000000C0000000000000000000
01010103400003140000311014795250000790000625000010800000003031343539404100000000000000000000000000000C0000000000000000000
0101010340000314000031101479115000079000049000001040132000029303134370000000000000353940410000000000C0000000000000000000
0101010340000314000031101479215000079000049000000980135000029303137000000000000000034370000000000000C0000000000000000000
010101034000031400003110147922500007900004900000132000000003539404100000000000000000000000000000000C0000000000000000000
01010103400003140000311014793150000790000490000009901200002930370000000000000000000031370000000000000C0000000000000000000
01010103400003140000311014793250000790000490000013000000000343539404100000000000000000000000000000000C0000000000000000000
01010103400003140000311014794150000790000490000009901200002930370000000000000000000031370000000000000C0000000000000000000
0101010340000314000031101479425000079000049000001190000000313435394041000000000000000000000000000000C0000000000000000000
010101034000031400003110147951500007900004900000100111000029370000000000000000000303700000000000000C0000000000000000000
01010103400003140000311014795250000790000490000010800000003031343539404100000000000000000000000000000C0000000000000000000
0101010340000314000031101479115000079000028000001040132000029303134370000000000000353940410000000000C0000000000000000000
0101010340000314000031101479215000079000028000000980135000029303137000000000000000034370000000000000C0000000000000000000
010101034000031400003110147922500007900002800000132000000003539404100000000000000000000000000000000C0000000000000000000
01010103400003140000311014793150000790000280000009901200002930370000000000000000000031370000000000000C0000000000000000000
01010103400003140000311014793250000790000280000013000000000343539404100000000000000000000000000000000C0000000000000000000
01010103400003140000311014794150000790000280000009901200002930370000000000000000000031370000000000000C0000000000000000000
0101010340000314000031101479425000079000028000001190000000313435394041000000000000000000000000000000C0000000000000000000
010101034000031400003110147951500007900002800000100111000029370000000000000000000303700000000000000C0000000000000000000
01010103400003140000311014795250000790000280000010800000003031343539404100000000000000000000000000000C0000000000000000000
0101010340000314000032201224115000024001000300002900350000110000000000000000000001300000000000000000C0000000000000000000
0101010340000314000032201224215000024001000300002900350000110000000000000000000001300000000000000000C0000000000000000000
0101010340000314000032201224225000024001000300002700000000113800000000000000000000000000000000000000C0000000000000000000
0101010340000314000032201224315000024001000300002901370000110000000000000000000003800000000000000000C0000000000000000000
0101010340000314000032201224325000024001000300002400000000111300000000000000000000000000000000000000C0000000000000000000
0101010340000314000032201232115000032074000000002900350000110000000000000000000001300000000000000000C0000000000000000000
0101010340000314000032201232215000032074000000002900350000110000000000000000000001300000000000000000C0000000000000000000
0101010340000314000032201232225000032074000000002700000000113800000000000000000000000000000000000000C0000000000000000000
```

Figure B-5. Operations File

```
4CCC0311000000004C00C31101237113110101010307000007000002000014000000000000000000000000000000000555212C000000000000000000000000000000
0CCC0000000000000000C0000C000000000C0C0000C000000000000000000000000000000000000000000000000C000000
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000C000000995000C0C00C0056C0C000000000000000000000001000000000000C0C000000000000000000000000000000C000000
4CCC031100000C00004C000311014791151501010103020000009900000000000000000000000000000000000000431929C000000000000000000000000000000
000C000000999C0CCC00CC056C0C000000000000000000000001000000000000C0C0000000000000000000000000000000000000
40CC031100000000C4C0003110147911214010C101C302C000C0990000000C0C000000000000000000000000000000431930C00000000000000000000000000C0C000
000C000000995000CCC00C0C56C0C000000C0CC00000C000C010C00000000000C00000000000000000000000000000C000000
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000C000000999000CCC00C0C56CCC00000000000C000000000010000000000000000C00000000000000000000C00000C000000
40CC031100000000004C00C31101479112C9010101030700000000000000000000C0C000000000000000000000000431934C00000000000000000000000000C00000
0CCC0C00000C0CCCCCC00CCC00C0C000CCC0CC0000C0C00000C00000000000000C000000000000000000000000C00000C000000
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0CCCCC0C00999000000C00C0043C0000000000000000000000000000C000000000000C0C00000000000000000000000000C00000C000000
4CCC031100CCCCCC4C00C311014791131101010103070000C000000000000C0C000000000000000000000000000C0431935C0000000000000000000000000000000
00000000000C0CC00C000C0C000000000000000001000000000000C0C000000000000000000000000000000C000000
40CC031100C0000C4C00C311014791122701C10103C3C000C0000000000C0C0000000000000000000000000000431939C0000000000000000000000000C00000
00CC000000CCCCCCCCC00CCC00C0000C000000000010000000000000C0C000000000000000000000000000000C000000
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40CC031100000000040003110147311214010101030200000000000000000C0C000000000000000000000000000060830C0000000000000000000000000C00000
0CCC000000CCCCC00C0C0C0C000C0000C000100000000000000C0C000000000000000000000000000000C000000
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0CCC000000C00C0C00C0C00C000CC00C0000100000000000000C0C000000000000000000000000000000C000000
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000C000000C0CCC0CC00C0C000C0C0000C000000000000000C0C0000000000000000000000000000000C000000
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4CCC031100C000C4C00C3110147311311010C10103C7C000C0000000000C0C0000000000000000000000000C0C60835C0000000000000000000000000C00000
000C0C0C0000C0CC0C00C0000C0000000000001000000000000C0C000000000000000000000000000000C000000
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000C000000000000CCC00CCC00C0C0C00C0C00010C000000000000C0C0000000000000000000000000000000C000000
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40CC031100000000C4C00C3110147911212010101030200000C0990000000C0C000000000000000000000000000062531C0000000000000000000000000C00000
00CC000000C0CC0CC0CC0C0CCCCC00C0C00100000000000000C0C000000000000000000000000000000C000000
40CC031100000000C4C00C31101479112C901C1010307000000000000000C0C000000000000000000000000000062534C0000000000000000000000000C00000
000C000000CCCCCC0CC0C00C0C0C00C0C00000000000000000C0C0000000000000000000000000000000C000000
4CCC0311000C000C4C00C3110147911334010101030800000700000200C0C140000000000000000000000000000062537C0000000000000000000000000C00000
0CCC0C0C00999C0C0C0C0006C0C0000C0000C000000000000000C0C000000000000000000000000000000C000000
4CCC031100CCC000C4C00C311014791131101C10103C7000C00000000000C0C0000000000000000000000000CC62535C0000000000000000000000000000000
000C0CC0C000C0CC0C0C0C0000C0C0000000001000000000000CC0C000000000000000000000000000000C00000C
```

Figure B-6. Assignment File

C. Master Status File

This section contains tables that describe in detail the input data and their formats in the Master Status File (MSF). This file is used by both TELOS and LEMOS and thus forms the main link between the systems. The format for the AREA-RECORD is shown in Table B-1, AREA-RECORD FORMAT. One card is needed for each unit area. The format for the STRUC-DATA is shown in Table B-2, STRUC-DATA FORMAT. One card is needed for each building type (Cols. 20-22) in each land use class present in the unit area. The format for the SHELTER-DATA record is shown in Table B-3, SHELTER-DATA FORMAT. The format for the PERSONNEL-STATUS Record is displayed in Table B-4, PERSONNEL-STATUS FORMAT. Table B-5, SPECIAL-RESOURCES FORMAT, give the format for the SPECIAL-RESOURCES Record. All CD resources are described using this format.

D. Problem File

Four general classes of problems are encountered in this file. Each class has a different format. A brief description of the record formats for these four major types of problems (i.e., Control, Increased Readiness, Damage, and Relief) are given in Tables B-6 through B-9. Records of two or more classes exist for each land-use entry within a unit area. Control and readiness problems are always present.

Problems that relate to the ability to identify, locate, direct, coordinate, or otherwise control the civil defense system are identified as control problems. One example is the inability to inform people due to the disruptions of communication facilities. The format of the corresponding PROB-TYPE-1 Record is shown in Table B-6, PROB-TYPE-1 FORMAT. Problems that relate to the vulnerability of people in a preattack situation or to

TABLE B-1. AREA-RECORD FORMAT

COBOL Variable	COBOL Format	Card Columns	Remarks
CODE-1	9	1	Value is 1.
FILLER	X	2	
TIME-PERIOD	9999	3- 6	Sequence number of time period
FILLER	X(5)	7-11	
ZONE-PART	999	12-14	Zone number
AREA-PART	999	15-17	Area number
T-INTERVAL	9(5)	18-22	In minutes
LAT	99V999	23-27	Latitude
LON	999V999	28-33	Longitude
TOTAL-AREA	9999V99	34-39	
LUC-PCT	X(20)	40-59	V99 occurs 10 times
CUR-DOSE-RATE	9(4)V9	60-64	r/hr
BLAST-RISK-CODE	9	65	
FALLOUT-RISK-CODE	9	66	
AREA-POP	9(6)	67-72	
SHELTER	9(6)	73-78	
GEN-STATUS-CODE	9	79	
FILLER	X(9)	80-88	

TABLE B-2. STRUC-DATA FORMAT

COBOL Variable	COBOL Format	Card Columns	Remarks
CODE-2	9	1	Value is 2.
FILLER	X	2	
TIME-PERIOD	9999	3- 6	Sequence number of time period
FILLER	X(5)	7-11	
ZONE-PART	999	12-14	Zone number
AREA-PART	999	15-17	Area number
LUC	99	18-19	Land Use Code
STORIES-CODE	9	20	
BLAST-RESIST-CODE	9	21	
FIRE-RESIST-CODE	9	22	
DAMAGE-CODE	99	23-24	
GEN-DEBRIS	9	25	
ROUTE-DEBRIS	9	26	
NO-UNDAM	9(6)	27-32	
NO-STAGE1	9(6)	33-38	
NO-STAGE2	9(6)	39-44	
NO-STAGE3	9(6)	45-50	
NO-STAGE4	9(6)	51-56	
AREA-AFLAME	99	57-58	
FILLER	X(30)	59-88	

TABLE B-3. SHELTER-DATA FORMAT

COBOL Variable	COBOL Format	Card Columns	Remarks
CODE-3	9	1	Value is 3.
SUBTYPE-CODE	X	2	Value 0 = spaces; value 1 = people
TIME-PERIOD	9999	3-6	Sequence number of time period
FILLER	X(5)	7-11	
ZONE-PART	999	12-14	Zone number
AREA-PART	999	15-17	Area number
LUC	99	18-19	
STORIES-CODE	9	20	Same as STRUC-DATA Record
BLAST-RESIST-CODE	9	21	
FIRE-RESIST-CODE	9	22	
TOTAL-SPACES	9(8)	23-30	(Or people if SUBTYPE-CODE = 1)
BELOW-PF-DIST	X(16)	31-46	V99 occurs 8 times
LOWER-PF-DIST	X(16)	47-62	V99 occurs 8 times
UPPER-PF-DIST	X(16)	63-78	V99 occurs 8 times
FILLER	X(10)	79-88	

TABLE B-4. PERSONNEL-STATUS RECORD

COBOL Variable	COBOL Format	Card Columns	Remarks
CODE-4	9	1	Value is 4.
FILLER	X	2	
TIME-PERIOD	9999	3-6	Sequence number of time period
FILLER	X(5)	7-11	
ZONE-PART	999	12-14	Zone number
AREA-PART	999	15-17	Area number
LUC	99	18-19	
STORIES-CODE	9	20	Same as STRUC-DATA Record
BLAST-RESIST-CODE	9	21	
FIRE-RESIST-CODE	9	22	
INJURY-CODE	99	23-24	
TRAPPED	9(6)	25-30	
UNINJ	9(6)	31-36	Those healed who originally suffered type of injury specified by INJURY-CODE
INJ-PHASES:	X(39)	37-75	
MEAN-TIME	99V9		
MIN-TIME	99	37-49	
MAX-TIME	99	50-62	X(13) occurs 3 times
CASUALTIES	9(6)	63-75	
MEAN-DOSE	999V9	76-79	
MIN-DOSE	999	80-82	
MAX-DOSE	999	83-85	
CD-PCT	V999	86-88	

TABLE B-5. SPECIAL-RESOURCES FORMAT

COBOL Variable	COBOL Format	Card Columns	Remarks
CODE-5	9	1	Value is 5.
SUBTYPE-CODE	9	2	Value 0=non-transient; value 1=transient
TIME-PERIOD	9999	3- 6	Sequence number of time period
FILLER	X(5)	7-11	
ZONE-PART	999	12-14	Zone number
AREA-PART	999	15-17	Area number
LUC	99	18-19	
FILLER	XXX	20-22	
ASSET-CODE	9	23	
ASSET-NUMBER	99	24-25	
POSTURE	99	26-27	
SUPV-COMP	9	28	Value 1 = non-CD; value 2 = CD
SUPV-ORGN	9(8)	29-36	Not used
CONDITION	9	37	
EFF-FACTOR	9V99	38-40	
QUANTITY	9(6)	41-46	
TRAILING-FIELDS:	X(32)	47-88	Only for Asset Codes 1, 2, or 3
(Facilities)			
FAC-DAM-CODE	99	47-48	
FAC-STAT-PCT	X(25)	49-73	9V9999 occurs 5 times
FAC-DEBRIS	9	74	
FILLER	X(14)	75-88	
(Shelter Spaces)			
SHEL-LVL-CODE	9	47	
PF-DIST	X(16)	48-65	99 occurs 9 times
FILLER	X(23)	66-88	
(Personnel)			
INJ-CODE	99	47-48	
TRAPPED-PCT	9V99	49-51	
INJ-PHASES:	X(30)	52-81	
MEAN-TIME	99V9		
MIN-TIME	99		X(10) occurs 3 times (once for each phase)
MAX-TIME	99		
INJ-PERC	9V99		
MEAN-DOSE	99V9	82-84	
MIN-DOSE	99	85-86	In tens of rads
MAX-DOSE	99	87-88	

TABLE B-6. PROB-TYPE-1 FORMAT

COBOL Variable	COBOL Format	Remarks
ZONE-1	999	
AREA-1	999	
LUC-1	99	
OLD-NEW	9	Defines old or new record
CLASS-1	9	Defines transient or non-transient resources
PROB-CLASS	9	Code is "1"
PROB-SET-1	99	
FILLER	X(5)	
UN-INFO	X	
UN-PROB	X	Not used, will be needed in
UN-ENVIRON	X	communication submodels.
RE-PROB	X	
UN-ASGN-RES		
TEAM-1	9(6)	
SPACES	9(6)	
CAP-UNITS-1	9(6)	Definition of capacity units vary from land use to land land use.
EQUIP-SETS-1	9(6)	
RATIONS-1	9(6)	
WATER-1	9(6)	
FUEL-1	9(6)	
SUP-UNITS-1	9(6)	Definition of supply units vary from land use to land use.

TABLE B-7. PROB-TYPE-2 FORMAT

COBOL Variable	COBOL Format	Remarks
ZONE-1		
AREA-1		
LUC-1	X(10)	Same as PROB-TYPE-1
OLD-NEW		
CLASS-1		
PROB-CLASS	9	Code is 2
PROB-SET-2	99	
INOP-PERS	9(6)	
INOP-EQPT	9(6)	
INOP-VEH	9(6)	
INOP-FAC	9(6)	
INOP-SUP	9(6)	
FAC-DAM	9(6)	
EQPT-DAM	9(6)	
SHORTAGE	9(6)	
UNPRO-PEO	9(6)	
EQPT-EFF-FACTOR	9V99	

TABLE B-8. PROB-TYPE-3 FORMAT

COBOL Variable	COBOL Format	Remarks
ZONE-1		
AREA-1		
LUC-1	X(10)	Same as PROB-TYPE-1
OLD-NEW		
CLASS-1		
PROB-CLASS	9	Code is 3
PROB-SET-3	99	
NO-FAC-DAM	9(6)	
FAC-FIRE		
NO-IGN-3	V999	
NO-AFLAME 1-3	V999	
NO-AFLAME 2-3	V999	
NO-BURNED-3	V999	
AREA-ASGN	9999V99	
NO-FAC-RAD	9(6)	
NO-FAC-3	9(6)	
FAC-DEBRIS	999	
FAC-RAD	9(5)V99	
LINK-DEBRIS	999	
LINK-JAM	9	
CHG-IND	X	
FILLER	X(6)	

TABLE B-9. PROB-TYPE-4 FORMAT

COBOL Variable	COBOL Format	Remarks
ZONE-1		
AREA-1		
LUC-1		Same as PROB-TYPE-1
OLD-NEW	X(10)	
CLASS-1		
PROB-CLASS	9	Code is 4
PROB-SET	99	
QTY-PEOPLE	9(6)	
PHASE-CODE	9	
CAS-TYPE	V99	Occurs 16 times
MEAN-TIME-OF-INJ	99V9	
TIME-OF-INJ (MIN)	99	
TIME-OF-INJ (MAX)	99	
MEAN-CAS-DOSE	999V9	
CAS-DOSE (MIN)	999	
CAS-DOSE (MAS)	999	
CD-CAS-CODE	9	

personnel, facilities and equipment by teams are readiness problems. The format of the related PROB-TYPE-2 Record is shown in Table B-7, PROB-TYPE-2 FORMAT. Damage control problems, unlike other problem types, are concerned with preventing the loss of a resource or its utility rather than improving an already degraded condition. Examples of this type of problem include firefighting, decontamination, and debris clearing. Table B-8, PROB-TYPE-3 FORMAT, shows the format for the corresponding PROB-TYPE-3 Record. The leading class of problems, which relates directly to the state of people, consists of shelter, rescue, treatment, and rehabilitation problems. It sets the standard for measuring the degree to which human life has been disrupted. All other problem groups must relate to this one and in this sense are subordinate to it. The format for such PROB-TYPE-4 Records is given in Table B-9, PROB-TYPE-4 FORMAT.

E. Other Example Files

Other files used as examples in Figures B-1 through B-6 include the Resource File, the Service File, the Operations File, and the Assignment File, the formats of which are shown, respectively, in Tables B-10 through B-13.

TABLE B-10. RESOURCE DATA FORMAT

COBOL Variable	COBOL Format	Remarks
PART-1		
ZONE-ID-2	X(3)	
AREA-ID-2	X(3)	
LUC-CODE-2	99	
FILLER	X	
CLASS-2	9	
ENVIRON-CLASS	9	
PART-2		
PART-2A		
BOS	9	
TOTAL-AREA-2	999V99	
NO-STRUC	9(6)	
TOTAL-TOTAL	9(6)	
CD-FORCE	9(6)	
TOTAL-UNINJ	9(6)	
RESOURCES		
RESOURCE	9(6)	Occurs 8 times
REFUGEES	9(6)	
PROB-CD	9(6)	
PROB-NCD	9(6)	
TOTAL-DEAD-1	9(6)	
CD-DEAD	9(6)	
CD-POSTURE	99	
AVG-UNINJ-DOSE(NCD)	999V9	
AVG-UNINJ-DOSE(CD)	999V9	

TABLE B-11. SERV-RECORD FORMAT

COBOL Variable	COBOL Format	Remarks
ADDRESS-11		
ORGN-11		
ZONE-11	99	
EOC-11	99	
GROUP-11	99	
SECTION-11	99	
SERVICE-11	99	
AREA-ID-11	X(6)	
TEAM-ID-11	99	
NO-TEAMS-11	9(6)	
FUNC-DIST		
PCT-BY-FUNC	V999	Occurs 8 times.
STATE-DISTRB		
PCT-BY-STATE	V999	Occurs 8 times.
NO-FUNC-11	99	
TEAMS-FORCE	9(5)V9	
TEAMS-LOST	9(5)V9	
SUM-RES		
RES-SUM	9(6)	Occurs 8 times.

TABLE B-12. OPS-DATA FORMAT

COBOL Variable	COBOL Format	Remarks
ORGN-10	X(8)	
AREA-ID-10	X(6)	
AREA-LINK-CODE	X	
OPS-ID-10		
ID-OPS-10		
ORIGN-10	X(6)	
OPS-LUC	99	
SEQ-10	99	
TYPE-10	9	
CODE-10	99	
ALT-10	9	
SEQ-10A	9	
ORIG-TIME	999V9	
DC-CODE	X	
PROBLEM-CODE	99	
STATUS-10	X	
OPS-QTY	9(6)	
START-TIME-10	999V9	
OPS-CODE	999	
OPS-STATUS	X	
COMP-OPS-CODE	999	
COMP-STATUS	X	
LIMIT-FUNC	XX	
BEN-TYPE	X	
TOTAL-FUNC-SET1		
OP-FUNC	99	Occurs 12 times.
TOTAL-FUNC-SET2		
OP-FUNC	99	Occurs 12 times.
OPS-PRIORITY		
RANK-OPS	9	
OPS-N		
OPS-1	9V9999	
OPS-2	9V9999	
OPS-3	9V9999	
OPS-4	9V9999	
FILLER	X(2)	

TABLE B-13. ASGN-DATA FORMAT

COBOL Variable	COBOL Format	Remarks
CUR-ADRS		
CUR-ZONE	XXX	
CUR-UA	999	
CUR-LUC	99	
DEST-ADDRS		
ZONE-4	99	
EOC-4	99	
GRP-4	99	
SEC-4	99	
OPN-4		
OPN-4-1		
ORGIN-4	X(6)	
LUC-4	99	
SEQ-4	99	
TYPE-4	9	
CODE-4	99	
ALT-4	9	
SEQ-4A	9	
MOBILITY-CODE	9	
TEAM-4	99	
ORGN-4		
ZONE	99	
EOC	99	
GRP	99	
SEC	99	
SERVICE-4	99	
RES-ASGN	9(6)	Occurs 8 times.
ASGN-QTY	9(6)	
FUNC-NO-4	99	
TIME-IN-FUNC	9(3)V9	
START-TIME	9(3)V9	
ARRIVAL-TIME	9(3)V9	
COMPLETION-TIME-EST	9(3)V9	
COMPLETION-TIME-ACT	9(3)V9	
THR-M	9(3)V9	
THR-I	9(3)V9	
THR-R	9(3)V9	
THR-O	9(3)V9	
PREP-THR	9(3)V9	
PROD-THR	9(3)V9	
BEN-CODE	XX	
NO-POT-BEN	9(6)	
IP-4	99V9	
SP-4	V9999	
SP-41	V9999	

TABLE B-13. ASGN-DATA FORMAT (Continued)

COBOL Variable	COBOL Format	Remarks
SP-42	V9999	
SP-43	V9999	
SP-44	V9999	
NO-ASGN	999	
FP-4	99	
AREA-ADRS2		
ZONE-ADRS	999	
AREA-ADRS3	999	
FILLER	X(38)	
LOCATION-3		
LOC3-ZONE	99	
LOC3-EOC	99	
LOC3-GRP	99	
LOC3-SEC	99	
AREA-3		
AREA3-ZONE	999	
AREA3-ADRS	999	
REC-CODE13	X	
REC-CODE23	9	

STANDARD

DOCUMENTATION

OUTLINES

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DAMAGE ANALYSIS OF LOCAL OPERATING SYSTEMS,(U)
MAY 79 R N HENDRY, R O LYDAY, T W DELLA DCPA01-77-C-0238

UNCLASSIFIED RTI/1531/00-01F NL

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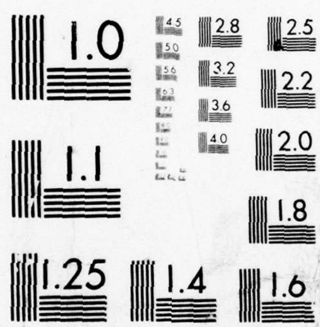

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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Final Report 44U-1531 DCPA Work Unit 4126J
DCPA Contract No. DCPA01-77-C-0238
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Hendry, R. N., R. O. Lyday, Jr., T. W. Della, and K. J. Reeves
May 1979 (UNCLASSIFIED)
95 pages

The research described herein covers a part of the "design" phase of a computer based dynamic system to Test and Evaluate Local Operating Systems, referred to as TELOS. The long term goal of this DCPA effort is to develop a computer-based dynamic simulation capable of supporting the TELOS both generically, wherein component research, training and national assessment roles are pursued, and, specifically, wherein planning and training roles give direction to local systems. The overall TELOS system is still incomplete although many of its missing elements are well defined. The primary activity during the current contract was concerned with testing and conversion of the LEMOS elements. All existing modules and submodels have been converted to operate on the UNIVAC 1100/10 computer at Olney, Maryland. That is, the same multi-area test runs have been successfully made on that machine. RTI recommends that extension to TELOS, including a communication submodel and an evaluation module, be started immediately, that detailed documentation of all modules be initiated, and further development effort be conducted using the UNIVAC 1100/10 remote terminal facilities at DCPACC. In addition, RTI recommends that the program plan outlined in this report become the basis for a fully validated DCPA program to reach the long term goal.

SIMULATION, SYSTEM EVALUATION, PROGRAM CONVERSION, MODEL

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